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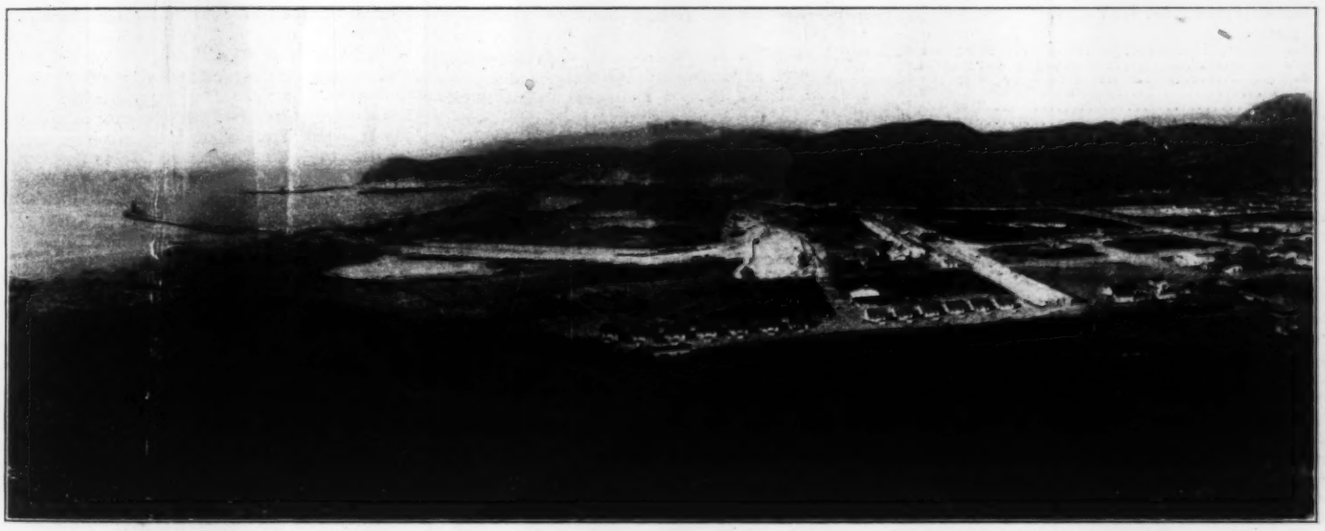
THE TEHUANTEPEC RAILWAY AND THE HARBORS AT ITS OCEAN TERMINALS.

The Tehuantepec National Railway, of Mexico, is an interoceanic line of special interest in its relation to and competition with the Panama Railway and Panama Canal. The railway is already in operation and the extensive terminals and harbor works are rapidly approaching completion. The isthmus of Tehuantepec is some 500 miles north and 900 miles west of the isthmus of Panania, and has a minimum width of about 150 miles, as compared with about 45 miles for the latter. The country is reported as being very healthy. This route was selected by Capt. Eads as the most favorable for his proposed interoceanic ship railway, and has also been the proposed site of numerous interoceanic railway and canal projects. In 1774 Augustin Cramer made a survey for a canal by direction of the Spanish viceroy, and in 1824 surveys were made for a national highway for the Mexican government, while in 1842 a concession for a canal was granted to De Garay, who had a survey made by an Italian engineer, Gaetano Moro. In 1846 this concession was acquired by an English firm, which in turn transferred it to a New York syndicate, and in 1850 a treaty was drawn up relative to a canal to be built under this concession. This treaty, however, was rejected by both the American and Mexican governments, and in 1851 the latter cancelled the De Garay concession. Various other concessions were granted from time to time, but without practical results. The present railway was commenced about 1880, but met with numerous vicissitudes and made very slow progress. More or less work was done at different times by various parties, and the line was eventually completed about 1896.

The railway was, at that time, however, far from being suitable for heavy traffic, and in the absence of proper harbor facilities at the terminals it was of little use for handling ocean traffic. In 1898, therefore, the Mexican government entered into a contract with the English engineering and contracting firm of S. Pearson & Son for the improvement of the railway, the construction of harbor works and port facilities, and the establishment of steamship lines in connection with the railway, so as to establish it as a link in an interoceanic commercial route. The railway is now owned jointly by the Mexican government and the English contractors in a 51-year partnership (dating from 1902), the latter firm acting as managing or active partner on behalf of the government. The railway is already completed and open for traffic, and the very extensive harbor works and deep-water terminals and shipping facilities will also soon be available, as noted more fully further on. It may be interesting to note that the railway connects with the Vera Cruz & Pacific Ry., and by it with the railway system of Mexico. With this latter line, also, there is communication between the long established and important Mexican port of Vera Cruz (on the Gulf) and the newer port of Salina Cruz (on the Pacific). The distance, however, is about 320 miles and the route is not adapted to the rapid or economical handling of freight. It is reported, however, that the Vera Cruz & Pacific Ry. will make extensive improvements in the way of grade reduction, strengthening of bridges, etc.



PANORAMIC VIEW OF HARBOR AND TERMINAL WORKS OF THE TEHUANTEPEC RAILWAY AT SALINA CRUZ, MEXICO.

Fig. 1. Map Showing the Relative Positions of the Tehuantepec Railway, Mexico, and the Panama Railway and Canal.

The Tehuantepec Railway is 189 miles long, and extends almost due south from its Atlantic terminal at Coatzacoalcos (on the Gulf of Mexico) to that at Salina Cruz, on the Pacific. In the new work and the improvement of the earlier portions the grades have been limited to 1.6% (compensated for curvature), and the curves to 8° on the main track; or with a minimum radius of 492 ft. The maximum elevation above sea level is 890 ft., this being at Niza Conejo, about 125 miles from the Atlantic. The track is of standard gage, and was originally laid with 56-lb. rails, but these are being replaced with 80-lb. rails of the Am. Soc. C. E. section, which have already been laid on 66% of the line; these latter have 13 or 14 ties to a rail length of 30 ft., while under the lighter rail the ties have been closed up to 18 per rail length. The ties are mainly of American pine or California redwood, with Servis steel tie-plates, but some of the ties are of native hardwood. About 66% of the line is ballasted with 12 to 15 ins. of crushed stone, the remainder is mainly ballasted with gravel. There is only one tunnel on the line, 300 ft. long. There were originally 838 bridge

openings, chiefly spanned by timber structures, but the number has been reduced to 257, all having iron or steel superstructures; this has been done by filling in trestles and replacing small bridges with culverts in solid banks. All recent bridges have been designed for consolidation (2-8-0) engines with 44,000 lbs. per driving axle, and train loads of 4,000 lbs. per ft. of track. The principal bridges are as follows:

Bridges.	Spans.
Tehuantepec	3 of 200 ft.
Santa Lucrecia	5 of 112 ft. and 2 of 50 ft.
Tolosa	3 of 119 ft.
Sarabia	1 of 119 ft. and 4 of 50 ft.
Malatengo	2 of 119 ft.
Chacalapa	3 of 76 ft.
San Geronimo	2 of 70 ft. and 4 of 60 ft.

The heaviest engines are 67-ton consolidation (2-8-0) engines; the ten-wheel type (4-6-0) is also largely in use. Some of them were designed for the use of oil fuel, and the others are being fitted to use the same fuel. The Beaumont, Texas, oil is used, taken in tank steamers from Port Arthur to Coatzacoalcos, where there is a storage tank of 1,500,000 gallons capacity. From this it is distributed to 6,500-gallon tanks at different points along the line. It is expected that eventually the oil wells on the isthmus will furnish a sufficient supply. Many of the box freight cars are provided with roof openings or hatches 10 × 8½ ft., covered by sliding steel doors, so as to facilitate the handling of freight by the dock cranes directly into and out of the cars. The equipment includes a weed-killing car, which sprays by steam a hot chemical composition over the vegetation which grows so rapidly in this region. The main shops are at Rincon Antonio, and have all the machinery operated by electric motors. The locomotives were built by the Baldwin Locomotive Works, and many of the freight cars by the American Car & Foundry Co. The average weight of freight trains is about 560 tons, and the trip between terminals is made in 13 hours by freight trains and 9 hours by passenger trains. There are 30 passing sidings, 2,000 to 3,000 ft. long, with a maximum distance of seven miles between sidings. The present traffic of the ports and railway amounts to approximately 75,000 tons per month.

The climate is an important element, and we are informed that for about two-thirds the distance from the Atlantic side the rainfall is heavy from the middle of June to January, inclusive, and at Coatzacoalcos during this period averages 14 ins. per month; for the balance of the year the rainfall is lighter, averaging about 2¾ ins. per month. On the other third of the distance, nearest the Pacific side, the rainfall is very light between June and December, and for the balance of the year there is practically no rainfall. The temperature at the highest point on the isthmus, 890 ft., which is about two-thirds the distance from the Atlantic toward the Pacific port, is from 86° to 92° F. in the shade during the warmest months, March to June. At both the Pacific and Atlantic ports it is between 92° and 98° F. During the rainy seasons the temperature falls, ranging between 75° and 85° F. near the summit, and 85° to 95° F. near the ports.

As the railway was built specially to serve as a link in a through route it has been provided with good terminal ports for the accommodation of shipping, and has been well equipped with piers, warehouses, freight handling machinery and railway yards and terminal facilities. The depth of water at the terminal wharves will be 32 to 40 ft. at low water. At both terminals the accommodation can be increased almost indefinitely. By the coming autumn the harbor works at both ends will be sufficiently advanced to permit the largest ocean-going steamers to discharge with safety in all weathers alongside the wharves directly into the cars or warehouses as required. Steamship lines are already using these ports, and additional services will be instituted by a number of existing ocean and coasting lines when the harbor works are completed, which will be in September.

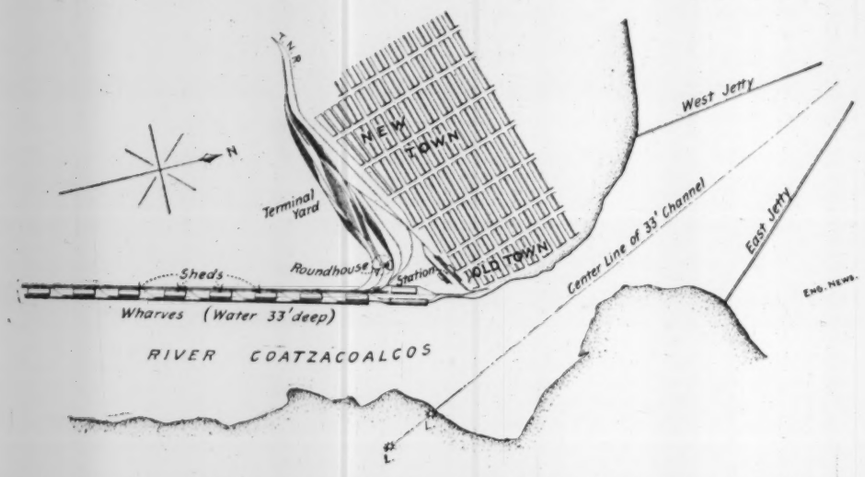


FIG. 2. PLAN OF ATLANTIC HARBOR AND TERM INALS OF THE TEHUANTEPEC NATIONAL RAILWAY AT COATZACOALCOS, MEXICO.

The general offices are at Rincon Antonio. Sir Weetman D. Pearson, of London, England, is President of the engineering and contracting firm and of the railway. Mr. J. B. Body, M. Am. Soc. C. E., is Resident Director; Mr. J. N. Galbraith, General Manager; Mr. D. Coe, Chief Engineer; and Mr. H. P. Durham, Superintendent of Motive Power. Mr. Robert Adam, of Mexico City, is Consulting Engineer for the harbor and terminal works.

HARBOR AT COATZACOALCOS.

The harbor at the Atlantic end is within the mouth of the Coatzacoalcos River, as shown on the plan, Fig. 2. There is plenty of deep water (up to 50 ft.) in the river and at the wharves, and it is anticipated that in a few months the depth of water on the bar at the mouth of the river will have been increased from 12 ft. to about 30 ft. This will be effected largely by the converging jetties or training walls, which are to be about 4,265 ft. long, built of loose quarry rock handled by 20-ton locomotive jib cranes. The jetties are rapidly approaching completion; eventually they will be topped with concrete blocks. The removal of the bar will be assisted by dredging. The wharves extend for a length of 3,640 ft. along the bank of the river. They are 85 ft. wide, of structural steel framework, supported by 6-in. solid steel piles and decked with timber; they carry railway tracks and are to be equipped with six electric cranes of 5 to 10 tons capacity, six steam cranes of 10 to 20 tons capacity, and six sets of conveyors, as well as electric capstans for the handling of cars. The conveyors are electrically operated, and are for handling sacks and other light cargo. In the rear of the wharves are steel frame sheds about 110 × 500 ft. Five of the wharves are ready and fully equipped, and Fig. 3 shows a part of the wharf with one of the steel sheds. The warehouses have roof hatches through which the cranes can handle the freight. Behind the wharves and sheds is the railway terminal yard, occupying a tract of land 6,560 × 656 ft. and having about 13 miles of tracks.

HARBOR AT SALINA CRUZ.

The port of Salina Cruz, on the Pacific, has been established in what was originally nothing but an open roadstead, and the outer harbor, 20 acres in area, is formed by two curved breakwaters, 3,280 ft. and 1,900 ft. long. This is shown in Fig. 4. The lower portion of each breakwater is a bed of heavy rubble stone, about 260 ft. wide at the base, 164 ft. on top, and extending to within 33 ft. of low water. Upon this is a bed of random blocks of concrete or quarry stone weighing about 25 tons each and deposited by a crane traveling upon rails laid along the partly completed work as it progresses. The crane has a large tower carrying a long horizontal boom composed of steel trusses, upon which runs the hoisting trolley. The boom revolves on a turntable on the traveling tower. The heaviest quarry block deposited weighed 56 tons, and each block usually requires a flat car to itself. This bed has an approximate slope of 1 to 1, and is finished with 40-ton concrete blocks 6.56 ft. high, and in two rows, making a top width of 33 ft. These are set in place by the crane, and the finished surface is 18 ft. above low water; a concrete parapet wall 19.7 ft. wide and 6.56 ft. high will be built later.

The crane is shown in Fig. 5, and behind it is one of the concrete blocks on a flat car. This view gives an idea of the size of the stone blocks

FIG. 3. STEEL WHARF AND WAREHOUSE SHED AT COATZACOALCOS, MEXICO; TEHUANTEPEC NATIONAL RAILWAY.

(On the slope of the roof next to the wharf are hatches for handling freight by the traveling cranes.)

handled. The work was done in about 60 ft. of water. The width of the entrance between the breakwaters is about 656 ft. The inner harbor is a tidal basin 3,280 × 730 ft., with a depth of 33 ft. at low water. This occupies the site of the old town and has been dredged out by two hydraulic or suction sea-going hopper

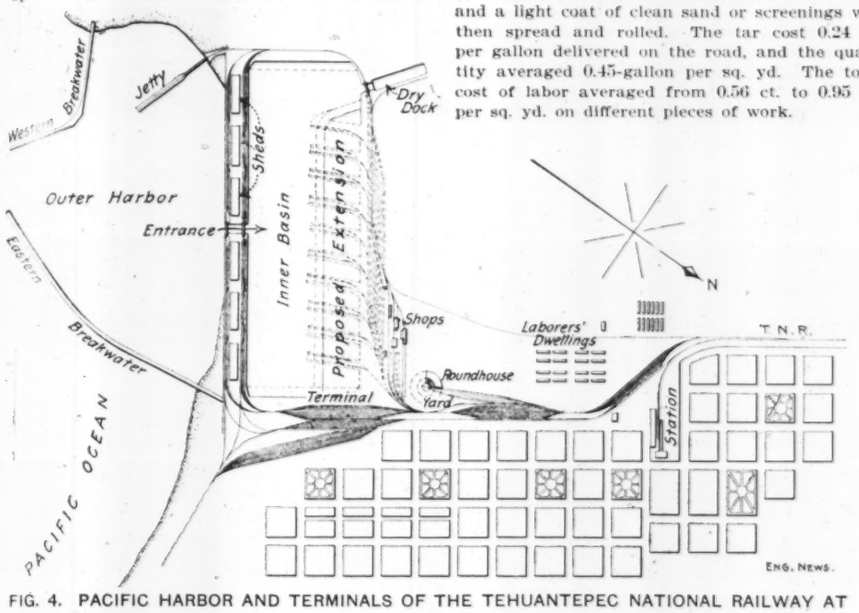


FIG. 4. PACIFIC HARBOR AND TERMINALS OF THE TEHUANTEPEC NATIONAL RAILWAY AT SALINA CRUZ, MEXICO.

dredges, having 20-in. and 24-in. centrifugal pumps. Between the basin and the harbor is a wall or quay, 19.68 ft. wide, 42.64 ft. long and 55 ft. high, built of monolithic concrete blocks, sunk in a dredged trench so that the top is 13.12 ft. above low water. On the outer or harbor side of the wall is sand and gravel filling protected by a rock fill bank 13 ft. wide, making a total top width of 230 ft. An entrance channel 98.4 ft. wide gives access from the harbor to the basin and is spanned by two swing bridges. Vessels enter the basin and lie alongside the quay or wharf, which is provided with sheds, railway tracks, steam and electric cranes, conveyors and capstans; the equipment is similar to that at Coatzacoalcos, already noted. When traffic requires, the basin will be dredged to a width of 1,215 ft., with ten piers and slips, as indicated by the dotted lines. The dry dock shown on the plan is already under construction; it is 600 ft. long, 100 ft. wide and 31 ft. deep. The excavated material is loaded into skips which are handled by a cableway, the material being dumped into railway cars and used for filling at the site of the freight yards, etc. Berths for two 12,000-ton steamers will be ready by July, and further wharf accommodation will be available a few months later.

The picture on page—— is a panoramic view of the harbor works. At the left are the two breakwaters (on one of which is the Titan crane) and the sea-wall or quay. To the right of the quay is one of the hopper dredges excavating the basin. Further inland are the railway terminal and the new town. This view was taken some months ago, the work being now nearly completed, as stated above.

TRIALS OF TAR AND OIL DRESSINGS ON MACADAM AND OTHER ROADS.

In 1905 careful experiments were made at Jackson, Tenn., with the use of tar and oil on macadam streets and country roads, under the direction of Mr. Sam C. Lancaster, City Engineer. The surface was first swept with a horse sweeper, loosened with spikes in the wheels of a 10-ton steam roller, and then sprinkled and rolled. The tar was heated before being put into the wagon, and was at a temperature of about 160° to 190° F. when distributed on the road by means of a 1¼-in. rubber hose with a nozzle of 1-in. pipe flattened at the end to deliver a broad stream. Laborers with street-cleaning brooms of bamboo spread the tar evenly and quickly in a layer only thick enough to cover the surface. Under a hot sun, the road absorbed practically all the tar in 8 or 10 hours, and a light coat of clean sand or screenings was then spread and rolled. The tar cost 0.24 ct. per gallon delivered on the road, and the quantity averaged 0.45-gallon per sq. yd. The total cost of labor averaged from 0.56 ct. to 0.95 ct. per sq. yd. on different pieces of work.

The streets and roads were in excellent condition after seven months service, including the past winter. They are hard and smooth, the surface resembling asphalt except that it is more gritty. The tar not only forms a part of the surface but makes a good bond with the macadam, sections cut from the streets showing that it has penetrated for 1 or 2 ins. and filled the small interstices between the stones.

About seven miles of streets and roads were sprinkled with different kinds of oil. The light crude oil was too volatile and produced little permanent effect, but the medium "steamer oil" from Texas gave good results, compacting the surface dust and making the road dustless and noiseless, and reducing the wear. This oil was heated by steam in the tank car, but was not hot when it reached the road. Some method of heating the oil in the distributing wagon, as by steam from a traction engine, would effect a great improvement, and the best results were obtained with the heavier oils when hot. The heavy residual oils were too thick to be spread properly when co'd. On a city street, with 0.48-gallon per sq. yd., the total cost of labor was 0.57 to 0.78 ct.; on a country road, with 0.38-gallon per sq. yd., the cost of labor was 0.33 ct. per sq. yd.

An ordinary earth road was treated with heavy oil after being shaped and graded; the soil was sandy, and the oil was harrowed into it and the road rolled. It is an improvement on the old road, as it does not cut into ruts like the sandy soil, but the results are not sufficient to warrant the use of oil where the price is high.

The above particulars are taken from a circular issued by the Office of Public Roads, U. S. Department of Agriculture, Washington, D. C., from which copies can be obtained on application by those interested in the subject.

FIG. 5. TITAN CRANE HANDLING STONE AND CONCRETE BLOCKS FOR BREAKWATER AT SALINA CRUZ, MEXICO; TEHUANTEPEC RAILWAY.

SEATTLE TO YOKOHAMA in 11 days 20 hours and 35 minutes was the record made by the Great Northern steamship "Dakota" on the west-bound trip ending June 20. This record is the more remarkable since the vessel was not built for high-speed passenger service, but, as noted in the description in our volume for July-December, 1904, p. 186, chiefly for freight service.

WEIGHT TABLE FOR STANDARD CAST IRON PIPE OF VARIOUS DIAMETERS.

The accompanying table has been sent to this journal by Mr. G. B. Zahniser, of New Castle, Pa. As may be seen, it gives the weights per 12 ft. lengths of 4 to 72 in. standard cast iron pipe, and also factors, in the third column, for ascertaining the weight in tons of any length of and size of standard pipe by a single multiplication. Mr. Zahniser suggests that similar tables can be readily computed for "light" and "extra heavy" pipe.

To Reduce Any Length of Standard Weight Cast Pipe to Tons (2,000 lbs.).

Diameter pipe, ins.	Weight per 12-ft. length.	Multiply total length of pipe by
4	264	.011
6	396	.01625
8	504	.021
10	720	.03
12	900	.03775
14	1,200	.05
16	1,500	.06225
18	2,004	.0835
20	2,400	.1
24	3,000	.1425
30	4,008	.1667
36	5,400	.2225
42	7,200	.3
48	8,700	.36225
60	12,900	.53775
72	18,720	.78

AN UNDERFLOW CANAL USED FOR IRRIGATION AT OGALALLA, NEBRASKA.

By Prof. Chas. S. Slichter.*

One of the alluring dreams of the western irrigator is to secure ground water for irrigation by means of gravity. A great deal of money has been spent in the effort to avoid the use of pumps in getting the water out of the ground, but the number of attempts hardly exceeds the number of failures. A few tunnels and infiltration galleries in California have continued to yield a small supply of water, but in nearly all cases the results have been great disappointments. The small underflow canal reported upon in the present paper comes nearer to being a success than any similar structure that has been seen by the writer.

UNDERFLOW DITCH AT OGALALLA.

This interesting development is located in the South Platte Valley, on the south side of the river, at Ogalalla, Neb., and is owned by Dr. A. Hollingsworth. The underflow ditch was constructed in 1895 and has been in use ever since. The excavation is about 12 ft. wide at the bottom, about 6,500 ft. in length, extending along the south bank of the river, reaching a total depth, in its upper portion, of 5 ft. below the bed of the South Platte River. A map of this ditch is given in the lower part of Fig. 1; the upper part of the figure represents in profile the bottom of the ditch and the South Platte River bed. The profile of the river bottom shown in the figure was made from elevations of the surface of the water in the river determined on Aug. 13, 1905. The river at this time was nearly dry, the water flowing in only a few small interlocking channels. The line of levels run on this day, extending from the section line shown at the left of the drawing to the section line two miles below, gave a drop of 16.7 ft. in the river water; or a slope at this point of 8.35 ft. to the mile. The distance from the head of the ditch to the line of test wells, as shown in the drawing, is 800 ft.; below this, the distance between consecutive dotted lines is 1,000 ft., measured along the line of the ditch. For the first 1,000 ft. above (west of) the point marked Weir No. 1, the bottom of the ditch is about on a level with the bottom of the river. For the next 4,000 ft. (west) its grade drops to 3.8 ft. per mile; and from thence to its head it again has approximately the grade of the river. From its head to within about 1,000 ft. of its outlet, near the bridge, the ditch is cut in sand; and from this point down to the point where it is carried up above the water plane, it passes through a kind of clay loam, through which there must be considerable seepage before the water reaches the point of application. On account of an unusually ample rainfall, the water recovered by the ditch was not used for irrigation during the summer of 1905, but was permitted to run back into the river, so that no opportunity was offered for measuring the loss from the lower part of its course.

*Consulting Engineer, U. S. Geological Survey, Madison, Wis.

A photograph taken near the mouth of the underflow ditch, and reproduced in Fig. 2, A, shows the size of the ditch near the point where the discharge or flow is greatest. The photograph shows the obstruction of the canal by rank vegetation growing within it. The beginning or head of the underflow ditch is shown in Fig. 2, B. At the time the photograph was taken a large amount of seepage was observed to enter from the south margin of the canal.

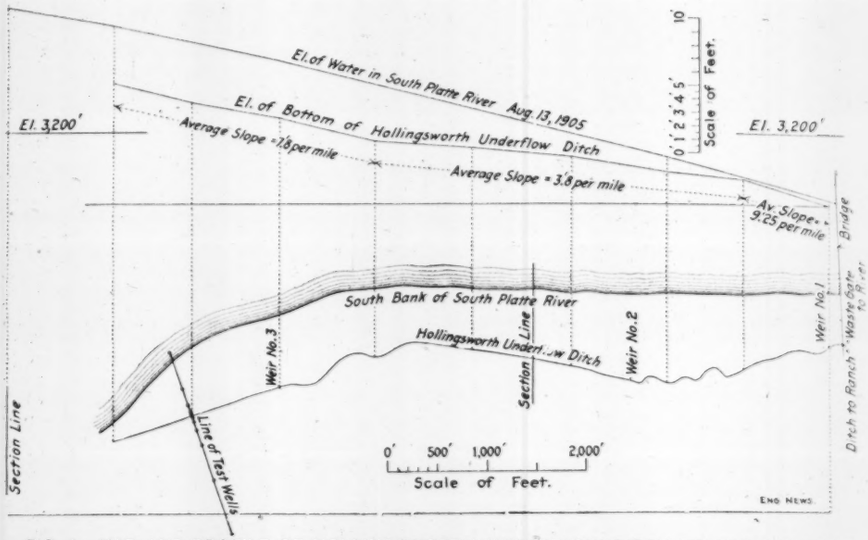


FIG. 1. MAP AND PROFILE OF HOLLINGSWORTH UNDERFLOW DITCH AT OGALALLA, NEB.

The lower portion of the diagram shows the location of the ditch with reference to the south bank of the river; the upper portion shows the elevation of the bottom of the ditch, and of the running water in the South Platte River on Aug. 13, 1905. The location of weirs placed in the canal for the purpose of measuring the flow are shown at the proper positions on the map; also the location of a line of test wells which were put in place to determine the elevation of the water plane near the ditch appears at the left of the diagram.)

The discharge from this ditch was measured with a current meter on Aug. 5, 1905, and was found to be 3.78 cu. ft. per sec. Later three weirs were placed at different points in the ditch and continuous records were kept for several days. These measurements are given in Table I. Weir No. 1 was put in at the bridge, as shown in Fig. 1, on Aug. 6, 1905. This location is near the mouth of the ditch. The discharge from the ditch, measured over the weir on Aug. 6 was found to be 3.77 ft. per sec., checking the measurement made the previous day with the current meter. Weirs No. 2 and No. 3 were put in place, at locations shown on the map, Fig. 1, on Aug. 7, 1905, after which the discharge over Weir No. 1 fell from 3.77 to 2.85 sec. ft. at corresponding hours of the day. This diminution of 0.9-sec.-ft. was due to the backing up of the water behind the two additional weirs, thus decreasing the effective head which forces the water into the ditch. When Weir No. 2 was removed on Aug. 19, 1905, the discharge over Weir No. 1 rose to 3.27 sec. ft., nearly the former amount, notwithstanding the facts that Weir No. 3 was still in place, and that the river had gone down 0.8 ft. The removal of Weir No. 2 lowered the surface of the water immediately back of it 1.38 ft. The measurements taken upon these weirs are given in Table I., and are represented graphically in Fig. 3. It was found that the discharge from the ditch changed appreciably with a slight change of elevation of the river water; for example, from 8 a. m., Aug. 15, 1905, to 8.30 a. m., Aug. 18, the river fell 0.2-ft., the discharge over Weir No. 1 fell 0.3-sec.-ft.; over Weir No. 2, 0.2-sec.-ft., and over Weir No. 3, 0.13-sec.-ft.

From this data the specific capacity of the gravels in the bottom of the ditch was found to be between 0.01 and 0.02 gals. per min. per sq. ft. of percolating surface under a head of 1 ft., a value which is much less than was expected. This result may be partially explained by the fact that no work had been done upon the ditch since the previous irrigation season. In conse-

TABLE I.—FLOW OF WATER IN HOLLINGSWORTH'S DITCH.

Year, 1905.	Time.	Flow over weir, sec. feet. No. 1.	No. 2.	No. 3.	Elevation of water in river, feet.	Remarks.
Aug. 6	4 p.m.	3.77	.....	.....	1.20	Weir No. 1 put in ditch.
7	5 p.m.	2.83	2.28	.....	.....	Weirs No. 2 and 3 put in ditch.
9	11 a.m.	3.06	2.36	2.22	1.05	
10	12 m.	3.03	2.82	2.13	0.84	
11	12 m.	2.67	.....	.....	.....	
12	12 a.m.	3.39	.....	.....	0.89	Heavy rain night of 11th.
13	8 a.m.	3.36	3.16	2.11	.....	12th very cloudy with local show'rs
14	12 m.	3.12	.....	.....	0.77	
Aug. 15	8 a.m.	3.36	3.14	2.16	0.70	
"	9.30 a.m.	3.34	.....	.....	0.70	
"	12 m.	2.97	.....	.....	0.67	
"	4 p.m.	3.06				
"	6 p.m.	3.16	.....	.....	0.64	
Aug. 16	8.30 a.m.	3.12	.....	.....	0.60	
"	10 a.m.	3.06	.....	.....	0.60	
"	12 m.	2.77	.....	.....	0.58	
"	2.30 p.m.	2.68	.....	.....	0.55	
"	7 p.m.	3.02	.....	.....	0.53	
Aug. 17	8 a.m	3.20	3.14	2.12	0.53	
"	12 m.	2.98	.....	.....	0.50	
"	2.30 p.m.	2.67	.....	....	0.50	
"	4 p.m.	2.72	.....	.....	0.50	
"	5.30 p.m.	2.94	.....	.....	0.50	
Aug. 18	8.30 a.m.	3.06	2.94	2.03	0.50	
"	10.45 a.m.	2.96	.....	.....	0.48	
"	4.45 p.m.	2.86	.....	.....	0.47	
Aug. 19	8 a.m.	2.96				
"	3.30 p.m.	2.67*				
Aug. 20	8.30 a.m.	3.59				
"	11 a.m.	3.40				
"	3 p.m.	3.27				
"	8 p.m.	3.55				
Aug. 21	8 a.m.	3.49				
"	9.30 a.m.	3.38				
"	12 m.	3.21				
"	3.30 p.m.	3.21				
"	4.15 p.m.	3.22				
"	7 p.m.	3.31				

* Weir No. 2 removed from ditch, Aug. 19, 3.30 p.m., lowering the water back of Weir No. 2, 1.38 feet.

A. Lower End of Ditch.

B. Head or Source of Ditch.

FIGS. 2A AND B. VIEWS OF HOLLINGSWORTH UNDERFLOW DITCH AT OGALALLA, NEB.

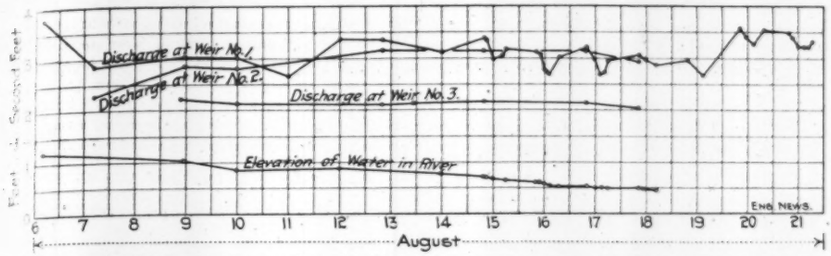


FIG. 3. DIAGRAM SHOWING DISCHARGE OVER WEIRS NOS. 1, 2 AND 3, IN THE HOLLINGSWORTH UNDERFLOW DITCH, AND THE ELEVATION OF WATER IN THE RIVER BETWEEN AUG. 6 AND 21, 1905.

(Small circles indicate the observed values. These are connected by straight lines, although more frequent observations would have shown a diurnal fluctuation in the discharge, and the straight lines would have been replaced by curves.)

quence a rank growth of vegetation sprang up, not only along the banks, but far out into the water, and at places extended from bank to bank. There was also a tightly attached covering of moss and algae over the entire bottom of the ditch.

The above results, while signifying little concerning the water-bearing qualities of the gravel, show that a very little extra expenditure of work upon the ditch would greatly increase its yield. The owner of the ditch at Ogalalla says that loosening the moss from the bottom of the ditch by dragging a log through it with a team of horses increases its discharge at least 50%.

It was further determined, from the measurements obtained, that the flow from the ditch fell off very greatly during the middle of the day, but remained nearly constant from the late afternoon until the late morning hours of the next day. The flow at midday was about 12% less than the flow during the night. The cause of this fluctuation was investigated, and the conclusion was reached that the decrease of water flowing in the ditch during the warmer hours of the day was not primarily due to evaporation from the water surface and the gravels near the ditch, but was mainly due to the enormous use of water by vegetation growing in and along its banks. An automatic tide gage was put in the ditch a few feet above Weir No. 1, from which a continuous record of the discharge over this weir could be computed. The results of these autographic records are given in Figs. 4, 5 and 6, together with the change in temperature of the air and of the water in the ditch.

An estimate of the evaporation from the surface of the water in the canal can readily be made. The length of the canal is 6,500 ft. and its average width is 12 ft., making the surface area 78,000 sq. ft. Evaporation experiments were conducted by the writer during the summer of 1905 at Deerfield, Kan., 200 miles south of Ogalalla, Neb., where the conditions were essentially the same as at the more northern point. The results are given in Table II.

TABLE II.—Evaporation in Inches of Water as Determined at Deerfield, Kans., from Aug. 6 to Sept. 3, 1905.

	Evaporation, ins. For 28 days.	Av. for 1 day.
Open water	10.90	0.39
Soil cultivated, 1 ft. to water	4.88	0.17
Soil uncultivated, 1 ft. to water	5.83	0.21
Soil uncultivated, 2 ft. to water	2.23	0.08
Soil uncultivated, 3 ft. to water	0.80	0.028

The result from open water is equivalent to an average evaporation of .0325-ft. per day, or a total average evaporation of 2,535 cu. ft. of water per day from the surface of the water in the underflow canal. If it be assumed that this loss took place during eight hours of midday, it should have shown itself by a falling off in the discharge from the underflow canal of 0.084 cu. ft. of water per sec. The actual observed loss amounted to 0.30 cu. ft. per sec. Thus direct evaporation can barely account for 23% of the observed loss. The evaporation from the wet banks at the sides of the canal may possibly have increased the loss to the equivalent of 0.10 cu. ft. per sec., still leaving two-thirds of the total to be accounted for by the consumption of water by vegetation and other losses.

A line of test wells (see Fig. 1) at right angles to the ditch, 800 ft. from its head, was put down for the purpose of determining the depression of the water plane in the neighborhood of the ditch. The profile of the water plane found in these wells is given in Fig. 7.

The point of especial interest in connection with the Hollingsworth underflow ditch is the fact that it is probably the only construction of its kind, found near any of the streams of the western plains, which can be considered a success. As previously stated, nearly all construction of

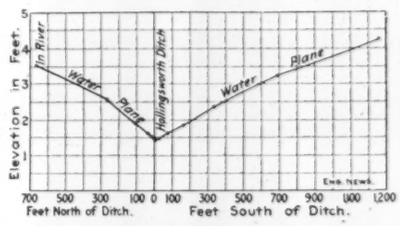


Fig. 7. Profile of Water Plane at Line of Test Wells Near the Head of the Hollingsworth Underflow Ditch.

(The position of this cross-section is given on the map, Fig. 1.)

this kind in other localities in the Western States have proved to be failures.

Conditions at this particular point are especially favorable for the success of such a structure. The fact that the size of the development is small has also contributed to its success. The slope of the South Platte River at this point is unusually great, amounting to about 1.6 ft. per 1,000. The minimum slope of the underflow ditch is 0.7 ft. per 1,000. The cost of construction was about $3,000, figuring at the standard rate the value of the owner's time and his teams used in the construction. The ditch requires cleaning at frequent intervals, at least once every two years, in order to remove the vegetation and the sand which tends to gradually ooze up from the bottom and fill the canal. From a financial standpoint the underflow ditch is about on a par with a steam pumping plant of the same capacity in the same location. The cost of operation is not very different from the cost of operating a Corliss condensing engine and centrifugal pump connected to a battery of driven wells during an average irrigation season, and there is little difference in the first cost. A pumping plant, in one respect, would be very much more satisfactory, inasmuch as there is constant danger that the underflow ditch will become a total loss at any time, due to an unusually heavy flood in the river breaking over the banks and filling the canal or washing it away.

CAUSES OF FAILURE OF UNDERFLOW CANALS.

As stated above, the percolation into Hollingsworth's infiltration canal, for each square foot of percolating surface, amounted to only .01 to .02-gal. per min., under 1 ft. head. Tubular wells constructed in these same gravels show a specific capacity of .25 to .50-gal. of water per min. per 1 sq. ft. of strainer surface, under 1 ft. head. The low specific capacity of the underflow canal is not only due to the vegetation and slime that obstructs the sand through which the water must pass, but is due mainly to the fact that stratified gravels do not readily transmit water if the water must travel across or perpendicular to the direction of the bedding. When tubular wells are placed vertically in bedded gravel, the coarser streaks of gravel drain the water into the well strainer and the capacity of the well is largely determined by the coarsest layers of the gravels encountered. In the underflow ditch the water must reach the surface by passing across or normal to the various beds of gravel, and the finest layer of sand controls the rate at which the water can enter the canal. On this account wells that penetrate the stratification of gravels perpendicular to the bedding are preferable to horizontal wells, or underflow canals that must follow the direction of the bedding. The same reasons explain why a deep tubular well of small diameter will furnish more water than a shallow dug well of large diameter.

An underflow ditch is also undesirable on account of the inelasticity in the amount of water which it will yield. The distance to which the water level is lowered by the underflow canal is fixed at the time of construction, and the daily yield cannot be increased beyond a certain maximum;

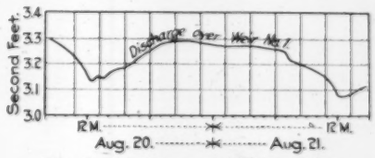


Fig. 4. Discharge and Temperature Records, Aug. 20 and 21, 1905.

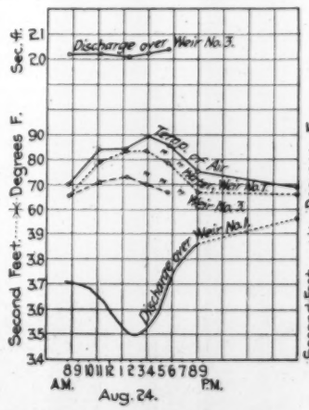


Fig. 5. Discharge and Temperature Records, Aug. 24, 1905.

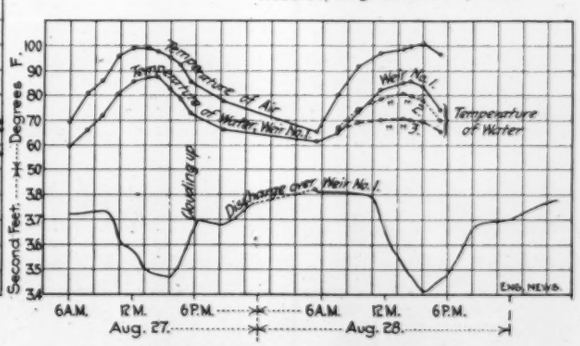


Fig. 6. Discharge and Temperature Records, Aug. 27 and 28, 1905.

FIGS. 4 TO 6. DIAGRAMS SHOWING DISCHARGE OF HOLLINGSWORTH UNDERFLOW DITCH AND THE TEMPERATURE OF THE WATER AND AIR IN AUGUST, 1905.

(Discharge over weir measured by an automatic recording water register. The curves show the sharp drop in discharge during the warmer part of the day and the nearly uniform discharge during the night, the latter on Aug. 27-28, in particular.)

in fact, at the very time when the most water is needed, say in the month of August, the yield of the underflow canal will be near its minimum value. When water is recovered by pumping from tubular wells, the vacuum of the pumps can be increased for short intervals of time to correspond to the increased demand for water.

It should also be noted that there are very few infiltration or underflow canals in actual use for irrigation purposes. There are many pumping plants in use for irrigation which have turned out to be both practicable and financially profitable; but the attempts to secure ground water by gravity have usually proved disappointing. There are numerous abandoned underflow canals in many parts of the West. An underflow ditch was constructed in 1890 in the valley of the Arkansas River, near Hartland, Kans., about 12 miles west of Deerfield, Kans., for the purpose of furnishing water to the Great Eastern Canal. In the summer following its construction the flow from the canal amounted to a little over 5,000 gals. per min. Water from the river overflowed the banks of the canal during a flood and partially filled it with sediment; at the same time the gravels in the bottom of the canal showed a tendency to work themselves upward by slow movement to the level of the ground water, cutting down materially the head under which the water entered the canal. The construction proved a complete failure and a great disappointment to the people. A large underflow ditch constructed at great expense near Dodge, Kans., has practically the same history as the one just described. The Denver Union Water Co. put an underflow gallery in Cherry Creek, at an expense of $200,000, and succeeded in developing only 5 cu. ft. of water per sec. An infiltration canal constructed at great expense near Sacatone, Ariz., on the Gila Indian Reservation proved a complete failure. A gravity infiltration canal was constructed on the Cimarron River, near Englewood, Kans., consisting of 900 ft. of stave pipe and 2,000 ft. of open canal. A flood in the river filled the canal with sand and mud soon after its completion, and its construction was a complete failure.

TRACK ELEVATION ON THE PENNSYLVANIA LINES AT CHICAGO.

During the past few years a great amount of track elevation work has been done in Chicago by a number of railways, and in all these cases the work has been executed under special difficulties due to the necessity of avoiding interference with railway traffic and with the street traffic at intersections. A general review of the Chicago track elevation scheme and methods of work was published in our issues of Jan. 11 and Feb. 22, 1900, while the work on the terminal line of the Chicago & Northwestern Ry. (under severe conditions of traffic) was described in some detail in our issue of Sept. 7, 1905. It may be noted here that all this work is done entirely at the expense of the railway companies.

The Pennsylvania Co. (Pennsylvania Lines West of Pittsburg) has had to elevate portions of both of its lines entering Chicago; the Pittsburg, Fort Wayne & Chicago Ry., and the Pittsburg, Cincinnati, Chicago & St. Louis Ry. The city's track elevation ordinances require the elevation of tracks and elimination of all street crossings at grade on the Pittsburg, Fort Wayne & Chicago Ry. from the Chicago River to the Indiana state line, a distance of 12.89 miles. By the end of 1904, this work had been completed on the section between 63d St. (Englewood) and 45th St., a temporary run-off with a grade of 1% reaching the old grade level at 43d St. This section included the elevation of a large freight yard, and its entire rearrangement as a gravity switching yard. In 1905 the work was extended north to 37th St., and some description of this is given below, as the unusual height to which the tracks had to be raised and the narrow space in which the work had to be done, made this of rather exceptional difficulty and interest. For particulars of this we are indebted to Mr. R. Trimble, M. Am. Soc. C. E., Chief Engineer of Maintenance of Way of the Northwest System, Pennsylvania Lines. The plans were prepared in his office, under the general supervision of the Chief Engineer, Mr. Thomas Rodd, M. Am. Soc. C. E. The work of construction was in the immediate charge of Mr. D. M. Craig, Assistant Engineer, from Mr. Trimble's office.

In planning the continuation of work for 1905, it was decided to extend it north from 45th St. to 37th St., with a run-off to 35th St.

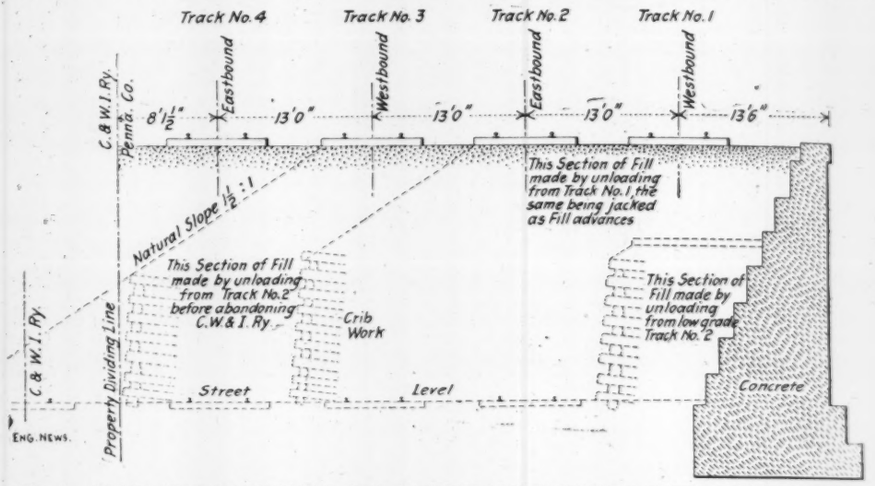


FIG. 1. CROSS-SECTION SHOWING STAGES OF TRACK ELEVATION WORK BETWEEN 45TH AND 37TH STS., CHICAGO; PITTSBURG, FORT WAYNE & CHICAGO RY.

This last street was at that time carried over the tracks by a steel viaduct, and was to be replaced by a subway, but it was decided not to cut out this crossing during 1905 on account of the risk of its remaining closed through the winter. The right-of-way of the Pittsburg, Fort Wayne & Chicago Ry. is about 60 ft. wide, and at this point is hemmed in by Stewart Ave. on the east and the right-of-way of the Chicago & Western Indiana Ry. on the West. The 60-ft. strip was occupied by four tracks (except for a short distance) and by a retaining wall which had been built before any filling was done. It was imperatively necessary that traffic should not be delayed during construction, and therefore that two tracks should always be kept in condition for the regular traffic. At 40th St. the tracks are crossed by the four-track line of the Chicago Junction Ry., and in order to provide the necessary clearance for trains on the latter road it was necessary to raise the Pittsburg, Fort Wayne & Chicago Ry. tracks about 23 ft. This additional elevation is attained by grades of 0.31 to 0.38% on each side of the summit at 40th St. Before starting work in 1905, an agreement was made with the Chicago & Western Indiana Ry. by which the Pittsburg, Fort Wayne & Chicago Ry. obtained the use of the easterly track of the former for the first part of the season, and in return that company obtained the use of two of the latter company's tracks, later on, for an equal number of track-days. Under this agreement, the main line traffic of the P., Ft. W. & C. Ry. was diverted on May 18 to its own western track and the adjacent track of the C. & W. I. Ry. The three easterly tracks of the P., Ft. W. & C. Ry. were

FIG. 2. CRIB WORK TO RETAIN FILLING AND KEEP LOW-GRADE TRACK OPEN.

FIG. 3. BUILDING RETAINING WALL FOR 23-FT. ELEVATION OVER THE CHICAGO JUNCTION RY. AT 40TH ST.

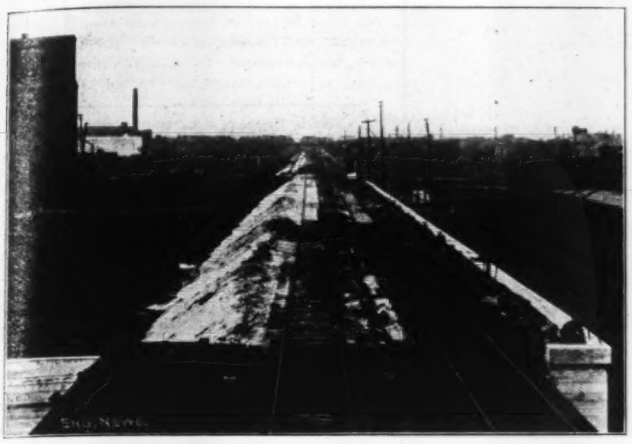


FIG. 4. TWO TRACKS ELEVATED AT 40TH ST.; PITTSBURG, FORT WAYNE & CHICAGO RY.

(Chicago & Western Indiana Ry. tracks on the old level at the left.)

then abandoned for construction purposes. The Chicago Junction Ry. agreed (through its Chief Engineer, Mr. J. B. Cox) to operate only two tracks across the right-of-way of the P., Ft. W. & C. Ry. and C. & W. I. Ry. during the period of elevation; the north and south tracks of this railway were therefore abandoned and removed, and the two center tracks were spread to permit of trestle bents being placed between them. As the work progressed, the Y-connections to the Chicago Junction Ry. were abandoned temporarily, and traffic between the two companies was handled by another route.

The retaining wall along the east side of the right-of-way was commenced in 1904, and was built between street crossings from 43d St. to 23d Place, gaps being left wherever industrial sidings or spurs left the right-of-way, and in one or two places where there were right-of-way complications. At the same time foundations for abutments at street crossings were put in wherever possible, the tracks being carried on stringers during this part of the work. The material used for filling was sand, as in nearly all other track elevation work in Chicago, and was obtained on the company's line at a distance of about 22 miles from Chicago. The sand was loaded into gondola cars by a steam shovel, and unloaded entirely by hand. Nearly all concrete was machine mixed, paddle machines being used for this work.

In accordance with this plan for carrying on the work, no effort was made to build abutments (except foundations) or piers, until after all tracks were raised. Temporary trestles were, therefore, constructed at each street crossing, piles being driven to a depth of 6 to 8 ft. below the bottom of the proposed excavation for pier and abutment foundations. At grade crossings where street railway tracks were in service, steel I-beams were used for spanning these tracks, thus avoiding the necessity for spreading them to clear a pile bent placed between them for the railway trestle. On account of the narrow working space, it was necessary to use cribbing for retaining the sand slopes, and for this purpose a crib work of old ties was constructed. With such a crib work, considerable sand drifted through, particularly on windy days, but the expense of keeping it cleared away from the track next to the crib was very slight. The cross section, Fig. 1, shows the cribbing and the different stages of filling, while the general character of the crib work is shown by Fig. 2.

As soon as tracks were abandoned for traffic, piles were driven for half-height trestles on track No. 1 at all street crossings. The trestles were then framed up, except in the center, where two spans were left open for street traffic. When the pile driver had completed its work track No. 1 was torn up and removed, crib work was built, sand was unloaded from track No. 2 to build the bank to half its height, or as high as it could be built by shoveling from gondola cars. Track No. 1 was then relaid on this bank. After completing the trestles on track No. 1, those for tracks Nos. 2 and 3 were built to full height, and these tracks were torn up and removed. Sand was next unloaded from track No. 1 at its new elevation, and this track was jacked to full elevation, the bridges being raised on extra caps as the track raising progressed. This work was done, however, in short stretches to avoid closing more than one or two streets at a time, and the work north and south of 40th St. was carried on independently, as this railway crossing could not be blocked by a low-grade bridge.

Having raised track No. 1 to full height throughout, a trestle was constructed across 40th St., and by using this track for unloading, the bank was widened for additional tracks, traffic being transferred from low track to high track one at a time, as the work progressed.

Fig. 3 shows the railway grade crossing at 40th St., with the east retaining wall under construction, and this gives some idea of the unusually high elevation at this point. Fig. 4 shows the same point with two tracks elevated. At the Root St. crossing, a view taken on July 6, 1905, shows the piles driven for track No. 1 at half height, and for No. 2 at full height. Fig. 5 shows the condition on July 27, with the street closed, the floor system in place for track No. 1, ready for the track and just before jacking up. By Aug. 6, the bridge for track No. 1 was raised to its full height on extra caps, so that the street was again open for traffic. Fig. 6 is from a view taken on Sept. 28, showing the crossing and temporary spans after the completion of the abutments. Frame bents were used just north of the street railway track on account of the electric conduits in the street at this point.

The grading, masonry, street work, trestles and the erection of the steel superstructures was all performed by contract. All track work was done by the regular organization of the railway company's maintenance-of-way department, and the regular track gangs were also used for constructing the crib work for retaining the sand filling where needed. A carpenter gang from the same department put in all stringers for abutment foundations, assisted in jacking up trestles as the grading progressed, and maintained all trestles under traffic.

The 35th St. viaduct has now been removed and the track elevation is being extended northward, the temporary run-off reaching the old grade level at 31st St.

ELECTRIC TRACTION FOR SUBURBAN TRAFFIC in and around London, England, is to be established by the Great Western Ry. This company's trains run over the underground lines of the Metropolitan Ry. which are now operated by electricity, but the electric train service has been hampered by the slower speed and slower acceleration of the steam trains. The Great Western Ry. has now equipped its suburban lines for electric service, using a four-rail system, the 103-lb. electric rails being of channel section with flaring sides, resting loosely upon cast-iron caps or studs inserted in porcelain insulators, with a Portland cement joint between the cap and insulator. The top of the positive rail is 3 ins. above that of the track rail, with its center line 16 ins. from the gage side of the latter. The negative rail has its top 1½ ins. above that of the track rails and is set in the middle of the track. During the busy hours of the day each train will consist of two motor cars and four non-motor cars, with a total seating capacity for 320 passengers. They are equipped with the multiple-unit system of control, and are designed for a regular schedule speed of 16 miles an hour, and a maximum of 30 miles per hour. Each motor car has four motors of 150 HP. The power station has eight three-phase generators of 750 KW. capacity, each directly connected to a triple-expansion engine; there are also two 150-KW. exciter units. Current is generated at 6,600 volts, 50 cycles, and is transmitted to three substations, the last one being five miles from the generating station. Here the current is converted and reduced to 630-volt direct-current for delivery to the positive or collector rail.

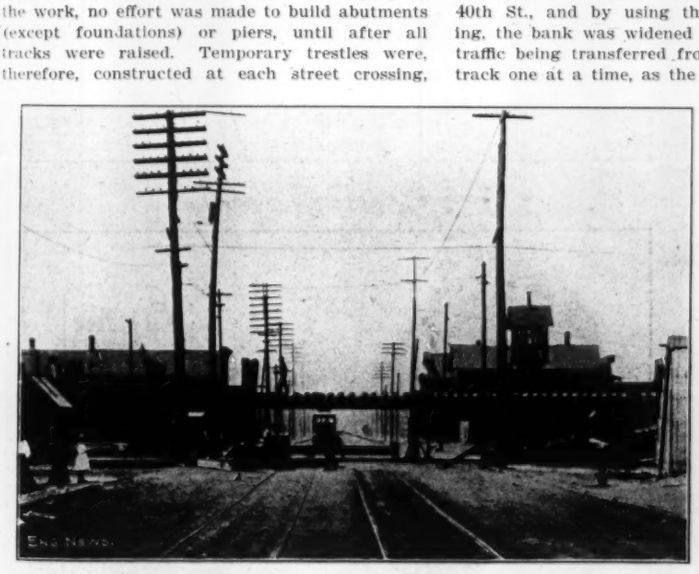


FIG. 5. FIRST STAGE IN TRACK ELEVATION AT ROOT ST.

Track No. 1 elevated to half height; piles and caps ready for track No. 2 at full height. Temporary spans of I-beams are used instead of timber trestle on account of street railway tracks.

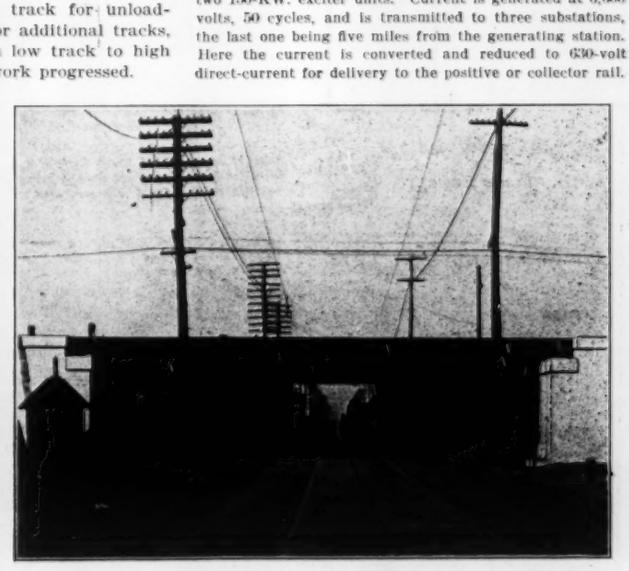


FIG. 6. TRACKS ON TEMPORARY SPANS ELEVATED TO FULL HEIGHT AT ROOT ST. CROSSING; PITTSBURG, FORT WAYNE & CHICAGO RY.

A UNIVERSAL DICTIONARY OF MECHANICAL DRAWING.*

By George H. Follows.†

Part IX.—Nomenclature and Written Matter.

130. In addition to the contents of the record strip, almost all mechanical drawings carry more or less written matter, as names of pieces, designations, bills of material, explanatory notes, references and special instructions; all of which depend largely for their efficiency upon the draftsman's common sense and knowledge of nomenclature.

131. Early in 1905 it was the writer's privilege to prepare a pamphlet on nomenclature for the Westinghouse Electric & Mfg. Co. The opening paragraphs of this pamphlet read as follows:

> It is extremely desirable that there shall be, throughout the business of the company, uniformity in the naming and describing of apparatus; in other words, uniformity of nomenclature.
>
> The word nomenclature, as here used, means "full descriptive name," and covers three features:
> (1) The individual terms, or "items" of a name.
> (2) The sequence of the items.
> (3) The phrasing of the items.
>
> The system of nomenclature outlined here is intended to affect names, titles, indexing and filing, throughout the Engineering Department, and especially in connection with the following:
> Naming of complete apparatus and of parts and details.
> Wording and arrangement in printed forms and on nameplates.
> Writing of specifications.
> Subjecting of correspondence.
> Titling of drawings.
> Titling and wording of catalogues and circulars.
> Indexing and filing in general.
>
> The pamphlet is thumb-indexed, so that the name of any machine or apparatus can be referred to instantly. The official method of description is read from numbered columns of

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†The Park View, East Liberty, Pittsburg, Pa.

Phrases	Items	Name
1	1	CIRCUIT BREAKER
	2	Carbon : Oil : Fused : Mag. Blow Out : Air
	3	Type (as, A, B, C, D)
2	4	Hand Operated | Elec. Operated | Pneumatic
	5	Front Connection : Rear Connection
	6	Swbd. Mounting : Wall Mounting : Direct Control
	7	Overload: O. L. and O. V. Underload: U. L. " U. V. Over Voltage: Non-Automatic Under Voltage: } Release
3	8	——Amps.——Volts A.C.——Volts D.C.
4	9	——Poles——Throw

Circuit Breakers

Fig. 35. Sample Page of Westinghouse Pamphlet on Nomenclature.

classified data, as shown in Fig. 35, which is a reproduction of the page devoted to circuit breakers. The sequence of items is obtained by reading "down" as numbered under "items." Items connected by dashes are the equivalent of a *single* item, and may be termed a "set"; except when part of a set no two items from the same line can be used at once. The preferred "phrasing" is indicated in the table by numbers under that head; the system of nomenclature requires the use of one written line per phrase, as in the following example description of a circuit breaker:

> Circuit braker: carbon: type A.
> Hand operated: overload release.
> Five amperes: 120 volts, D. C.
> Four poles: 16-in. throw.

In this example the items, their sequence and phrasing are in accordance with the table.

133. In the titling of a drawing it is not always desirable to use a full description of the apparatus; none but orthodox names should be used however; and when possible the official sequence and phrasing of the items should be employed, as in the following example title:

> Circuit Breaker: carbon: type A
> Hand operated: overload release
> General Drawing

134. Just how it came about that the matter of nomenclature received this special attention from the Westinghouse Company has so direct a bearing on the leading features of this chapter that a brief account may not be out of place here.

135. In 1899 the drafting room of the above company was finding employment for something over one hundred men, and up to that time about 25,000 drawings had been made and put on file. The chief draftsman, a Mr. John W. Meserve, then newly appointed—a man of great executive ability and of long experience in the managing of large drafting rooms, was dissatisfied with the lack of system that he found, but it was impossible for him to devote time to a thorough investigation. The making of this investigation fell to the writer's lot. A study of conditions revealed among other things much confusion in the matter of nomenclature. Different men called the same thing by different names, or what was quite as bad, meant different things by the same name; and drawings that were titled similarly did not contain similar parts; so that the drafting room, office and shop were continually misunderstanding one another.

136. An important step was made leading towards a system of nomenclature when the first "element chart" was developed, as reproduced here in Fig. 36. This is one of about thirty that

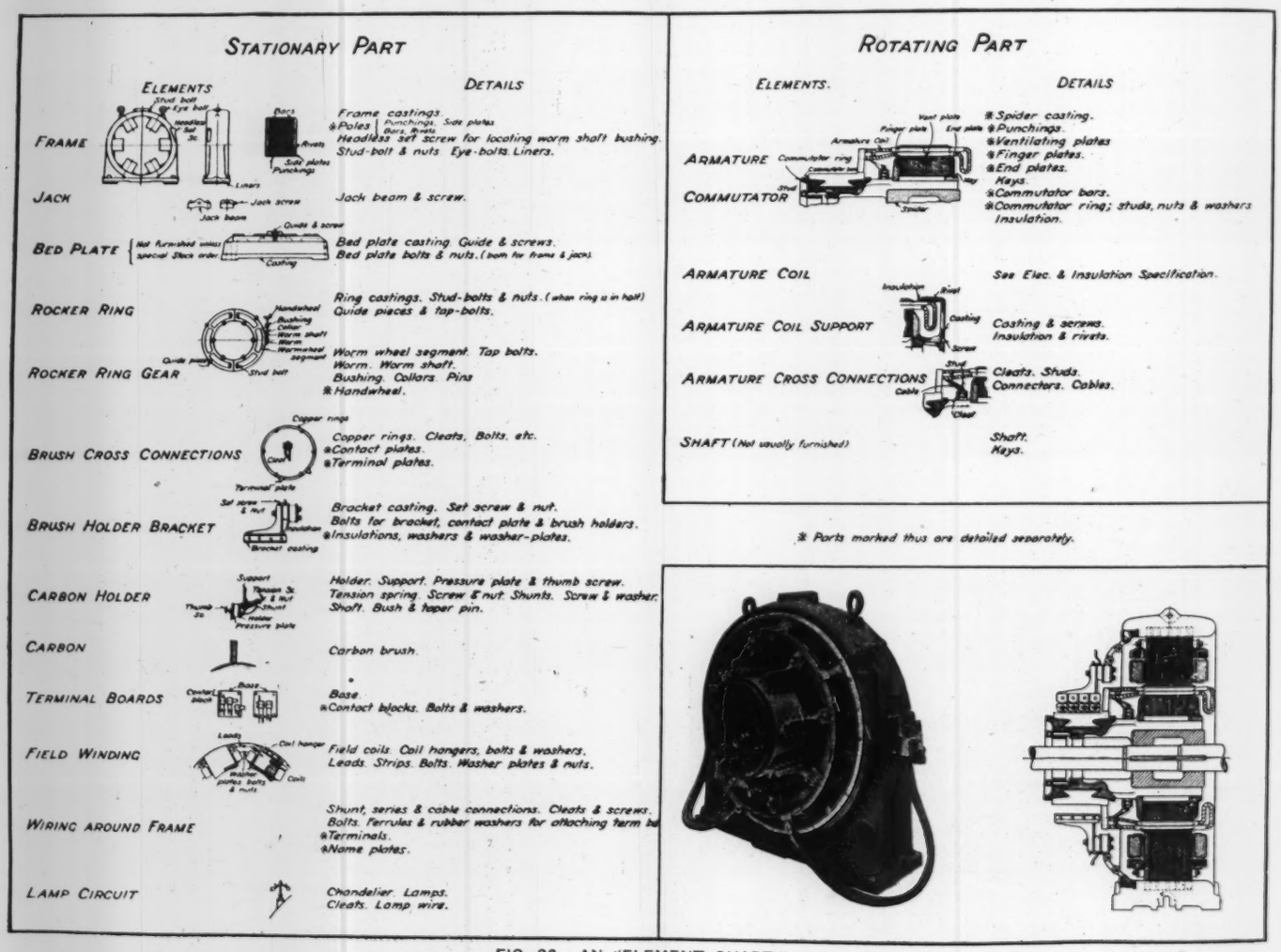


FIG. 36. AN "ELEMENT CHART."

UNIVERSAL DRAWING DICTIONARY.

The designations given below are representative examples for draftsmen to imitate. Many of them follow commercial usage. As a general rule, in specifying pieces of raw material, as wire, rod, sheet and strap, the thickness or diameter is given *after* the other dimensions; in specifying finished articles, as screws, bolts, rivets and escutcheon pins, the diameter should be given *first*.
In these examples, to avoid tiresome repetition, the "quantity required" is generally omitted.

FASTENERS

$\frac{1}{2}$" x 3$\frac{1}{4}$" Dowel pin, Req. 3
$\frac{7}{8}$" x 6$\frac{1}{2}$" M.B. Mach. B., Req. 15
$\frac{3}{4}$" x 9" Stud, Req. 38
$\frac{5}{8}$" x 2$\frac{3}{4}$" M.B. Tap. B., N.P. Req. 8
$\frac{5}{8}$" x 1$\frac{1}{2}$" Cap Sc., C.H. Hd.
$\frac{3}{16}$" x 1$\frac{3}{4}$" Spring Cotter
#16 x $\frac{3}{8}$" Escutcheon pin
$\frac{3}{8}$" x $\frac{1}{2}$" x 4" Feather key, steel, Req. 2
$\frac{3}{8}$" x 2$\frac{1}{2}$" Lag Sc.
1$\frac{1}{4}$" Hex. Nut
$\frac{5}{8}$" Lock nut
Wing nut, #73, Req. 8
$\frac{1}{4}$" x 1$\frac{1}{4}$" Rd. Hd. I. Rivet
#7$\frac{1}{4}$ x $\frac{1}{2}$" Flat Hd. I. Rivet
$\frac{3}{16}$" x $\frac{1}{4}$" Flat Hd. Csk. Copper Rivet
#9 x $\frac{3}{8}$" Copper belt-rivet
$\frac{3}{32}$" x $\frac{5}{16}$" Copper jacket-rivet
$\frac{1}{8}$" x 1$\frac{1}{16}$" Pin, C.R.S., Req. 31
#14-24 x 1$\frac{1}{2}$" Fil. Hd. B.M.Sc.
Hex. Hd. Set Sc. #248, Req. 60
$\frac{1}{2}$" Eye bolt, Req. 1
Jack Sc. #743, Req. 1
$\frac{1}{2}$" x 1" Hdlss. Set Sc. C.H., Req. 2

INSULATING MATERIALS

3$\frac{2}{64}$" x 5$\frac{13}{32}$" x $\frac{1}{16}$" Sh. Asbestos, Req. 3
Distance piece, 24" x 12" x $\frac{1}{8}$" fibre
$\frac{7}{8}$" x $\frac{3}{16}$" Rod, red fibre, Req. 6
3 Layers of .056 F.B., for building up coils to 1$\frac{1}{4}$", Req. 16
3 Layers of .056 F.B., Treated and cemented together with shellac.
1$\frac{5}{8}$" x 3$\frac{7}{16}$" x $\frac{1}{32}$" Mica, Req. 8
5" x $\frac{3}{4}$" Rod, semi-hard rubber.
22" x 36" x 2" Soapstone

ROD

1$\frac{1}{4}$" x .085 Drill rod, Req. 3
#6-32 Nut, from $\frac{3}{16}$" x $\frac{3}{8}$" Hex. B. Rod.
From half round .162 B. Rod, $\frac{1}{2}$" long.

SHEET & PLATE

Punchings of .0172 sheet steel
.0625 Steel, 3 at each end, Req. 6
24" x 82" x $\frac{3}{8}$" Plate, steel, Req. 4

TUBING

3$\frac{3}{4}$" of .8718 x 1" Seamless B. Tubing
$\frac{3}{16}$" x $\frac{1}{4}$" W.I. Pipe, Req. 21$\frac{1}{2}$"

MISCELLANEOUS

$\frac{1}{4}$" Lock washer, Req. 3
8$\frac{1}{2}$" of .007 G.S. Wire, Req. 6
10 Turns of .024 Music wire, Req. 8
#12 Torpedo twine, Req. 20 Ft.
1" x $\frac{1}{4}$" Felt; cut to suit, Req. 3
1" x 4$\frac{1}{2}$" x $\frac{1}{2}$" Pad, Leather.
$\frac{3}{8}$"-16 Thds.
#24-16 Tap.
$\frac{5}{8}$" Tap, 11 Thds. per inch.
.201 Drill & $\frac{7}{16}$" Cbr., $\frac{3}{8}$" deep.
Made from 1$\frac{1}{2}$" x $\frac{1}{16}$" Copper strap, about 2$\frac{3}{8}$" long, Req. 3.
Taper 1".219 per foot on diameter.
3" x 10" x $\frac{3}{4}$" Hard wood, Req. 2

The above examples indicate when a word should begin with a capital letter. In general, capitalize the first word in a designation, all abbreviations, and the word immediately following an abbreviation.

An explanatory or descriptive note added as auxiliary to the designation should be placed *under* the designation, so as to leave the "quantity required" at the end of a line, thus:-

$\frac{3}{4}$" x 6" Tap B., Head S.F. & Blued, Req. 8
For securing bracket to leg.

FIG. 37. EXAMPLES OF DESIGNATIONS.

were compiled. Each machine was divided into "elements," each element consisting of certain specified details, and every part was officially named. With these charts in their possession draftsmen had no excuse for using irregular names or titles, and their influence was soon felt throughout the factory, so that in talking or writing about details of construction there came to be less and less misunderstanding, and a much more harmonious condition prevailed.

137. These element charts almost immediately led to the adoption, for each type of machine, of special printed lists—called "drawing lists"—for the transmission of information from the drafting room to the shop. This was another step in the right direction. In these lists the correct names of the parts were arranged in the same order as on the charts. Finally in order to insure uniformity in the *describing of complete apparatus*, the pamphlet on nomenclature was written.

138. Very little need be said here about *how* to give a name to a piece of machinery, except, perhaps, that it should never be done thoughtlessly. While a new machine is being designed, it should be divided into natural or suitable "elements," and these into "details" sensibly named. It is not at all uncommon to find included in the name of a piece the name of a *material*. This is distinctly poor practice. The already established principle that "drawings should be made right to stay right" has a direct application here; if, for instance, terms like "wooden ring," "fiber washer" are allowed to creep in, and it is decided later—we will say a year later after all catalogues and circulars have been issued *using these terms*—that the ring is better of fiber and the washer of brass, there have been introduced two very absurd names, for we shall have a wooden ring made of fiber and a fiber washer made of brass; and it will not be at all an easy matter to stop the use of these names.

139. In most drafting rooms the naming of parts and details—where names are used in preference or in addition to numbers—is done without sufficient consideration; a habit of carelessness too often prevails, the result being names that do not fit and that cause trouble in many little annoying ways. The remedy lies almost entirely in a personal appreciation of the necessity of using care.

140. But the *name* of a piece is only a part of what may be called the draftsman's *designation* of it, which often includes several items, as dimensions, material, finish, and quantity required. Taking the last of these: On the first thought it would not seem difficult to find one way—one universally acceptable way—of specifying quantity required; and yet an examination of the drawings made by different men in different drafting rooms revealed a variety quite surprising in its range. The following are some of the different ways in which English speaking draftsmen have specified required quantities in actual working drawings made during the past fourteen years:

3	Take 3
Three	Use 3
3 wanted	Get 3
3 needed	3 thus
3 of these	make 3
3 of them	Want 3
3 of this	3 required
3 off	3 like this
3 of	3 per machine.

141. And this variety in the term is supplemented by changes of its position in the complete designation; thus, taking a simple example, a complete designation may read:

Make 3 Dowel pins ½-in. × 3¼-in.
or ½-in. × 3¼-in. Dowel pin, make 3
or Make 3 — ½-in. × 3¼-in. Dowel pins.

142. But to return to the manner of specifying quantity required; during the investigation already referred to it was finally decided to use "Require"—abbreviated "Req."—and to follow it by the quantity number, as Req. 3: the great advantage of this word is that it is general in its significance, for whether a piece has to be made, or bought, or taken from stock, it is always "required." It was further decided that in all designations this should be the last item, thus:

½-in. × 3¼-in. Dowel Pin: Req. 3.

In this arrangement there is no danger of confusing the "quantity figure" with any other figure in the designation.

143. The example designations presented in Fig. 37 are intended for draftsmen to imitate. It will be noticed that in many of them *abbreviations* are quite freely used. In this connection it is not easy to lay down any very useful principle, except perhaps to say that *it is permissible to abbreviate any term if it is quite certain that no misunderstanding will ensue.*

144. It has so long been the habit of draftsmen to designate the much used metals by their initial letters, that the custom may be looked upon as practically universal. With regard to abbreviations in general, the writer is somewhat chary of making suggestions. In designations and

UNIVERSAL DRAWING DICTIONARY

PHYSICAL QUANTITIES: Symbols.

Length	L, l
Mass	M
Time	T, t
Surface	S, s
Volume	V
Velocity, linear	v
" angular	ω
Acceleration	a
Force, or Weight	F, f
Work	W
Power	P
Pressure	p
Moment of inertia	K

METALS

Aluminum	Almn.
Babbitt	Bb.
Brass	B.
Bronze	Bz.
Carbon	Cbn.
Cast brass	C.B.
Cast copper	C.Cop.
Cast iron	C.I.
Cast steel	C.S.
Cold rolled steel	C.R.S.
Copper	Cop
Lead	Lead
Malleable iron	M.I.
Open hearth steel	O.H.S.
Phosphor bronze	Ph. Bz.
Steel	Steel
Steel casting	S.C.
Wrought iron	W.I.
Zinc	Zn.

GAUGES

Brown & Sharpe, or American Standard Wire Gauge	B.&S.
Birmingham, or Stubs' Iron Wire Gauge	B.W.G.
National, or Roeblings, or Washburn & Moen's	N.W.G.
Music Wire Gauge	M.W.G.
United States Gauge	U.S.G.
Twist Drill & Steel Wire Gauge	T.D.G.
Stubs' Steel Wire Gauge	S.W.G.

THE MONTHS

Jan. Feb. Mar. Apr. May June.
July Aug. Sept Oct. Nov. Dec. Dec. 3. 06

TIME

By the clock	$2^h\ 15^m\ 46^s$
Duration	2h. 15m. 46s.

FASTENERS

Button head bolt	Btn. Hd. B.
Cap screw	Cap Sc.
Double chamfered hexagon nut:	Dbl. Chmfd. Hex. Nut
Eye bolt	Eye B.
Fillister head brass machine screw:	Fil. Hd. B. M. Sc.
Fillister head iron machine screw:	Fil. Hd. I. M. Sc.
Flat head wood screw	Flat Hd. Wd. Sc.
Flat head stove bolt	Flat Hd. Stove B.
Headless set screw	Hdlss Set Sc.
Hexagon nut	Hex. Nut
Lag screw	Lag Sc.
Machine bolt	Mach. B.
Machine screw nut	M. Sc. Nut
Milled body tap bolt	M. B. Tap B.
Set screw	Set Sc.
Square nut	Sq. Nut
Stud bolt	Stud B.
T-head bolt	T-Hd. B.

WEIGHTS & MEASURES, etc.

Center	Cr.
Center line	~~Cr.~~
Centimetre	cm.
Circular mils	C.M.
Circumference	Circum.
Diameter	dia.
Electromotive force	E.M.F.
Foot, feet	Ft.
Horsepower	HP
Inch, inches	In.
Kilogram	Kg.
Kilometre	Krn.
Kilowatt	KW
Millimetre	mm.
Ounce, ounces	Oz.
Pound, pounds	lb.
Radius	Rad. or R.

MISCELLANEOUS

Alternating current	A.C.
Amperes	Amp.
Board	Bd.
Bracket	Bkt.
Building	Bldg
*Candle power	C.P.
*Circular pitch	C.P.
Case harden	C.H.
Company	Co.
Counterbore	Cbr.
Countersink	Csk
Cylinder	Cyl.
Degrees Centigrade	10°C
Degrees Fahrenheit	10°F
Department	Dept.
Direct current	D.C.
Drawing	Dwg.
Electrical	Elec.
Experiment	Exp.
Feather	Fthr.
Flexible	Flex.
General	Gnl.
Hexagon	Hex.
Machine	Mach.
Manufacturing	Mfg
Material	Mtl.
Maximum	Max.
Minimum	Min.
Negative	Neg.
Not to scale	N.T.S.
Nickel plate	N.P.
Number: For designating	No. or #
Number: Quantity	Nbr.
Pattern number	Pat. # 3178
Per cent	%
Positive	Pos.
Railway	Rwy.
Revolutions per minute	R.P.M.
Rotating part	Rotor
Round	Rd.
Seamless	Smlss.
Sketch	Sk.
Specification	Spec.
Square	Sq.
Standard	Std.
Stationary part	Stator
Temperature	Temp.
Threads	Thds.
Weight	Wgt.

*Here the meaning of the abbreviation depends entirely upon how it is used. This is largely true of most abbreviations. †

In "a lamp of 16 C.P." it is perfectly evident that the meaning is "candle power."

In "a gear of ¾" C.P., 72 teeth," it is just as evident that the abbreviation means "circular pitch."

†Unless the words adjacent to an abbreviation unmistakably suggest its true meaning, the abbreviation should not be used.

FIG. 38. EXAMPLES OF ABBREVIATIONS.

tabulated information—such as bills of material—they are almost a necessity, in order to get compactness; it would certainly be a hardship if draftsmen were compelled to use the full term "fillister head iron machine screw." On the other hand a promiscuous use of abbreviations in written notes should be avoided, as should any term of doubtful meaning. Some abbreviations that have been found useful are listed in Fig. 38.

145. It is often convenient to use commercial or "trade" terms on drawings. Unfortunately many of these terms and their meanings are subject to change without notice; and again the same term may have different meanings in different parts of the country; but we have as yet no recognized standard dictionary of mechanical terms, so that the whole conditions of affairs is beyond the draftsman's control and is something, therefore, that it is useless for him to worry about. The draftsman should, however, know the difference between a washer and a sleeve, between a bolt and a screw, a shoulder and a collar, a lever and a link, and he should know the meanings of all the simpler mechanical terms, many of which the average draftsman of to-day uses with very little discretion. The following are a few definitions that the writer developed for his own benefit when at the board, they are given here merely as examples:

A washer is a circular plate of uniform thickness with a circular hole through the middle.

A washer-plate is a plate used as a washer that is not fully described by the term washer; thus it may be square and have several holes in it.

A lock-washer is a washer specially designed to prevent a threaded nut from jarring loose.

A collar is a ring of any shape secured around a shaft or similar part when placed there as an end bearing or stop. A shoulder should never be called a collar.

A bush is a tube of any shape that either is or is not secured to what surrounds it but that is not secured to what it surrounds.

A sleeve is a tube of any shape that either is or is not secured to what it surrounds but that is not secured to what surrounds it.

146. At a banquet given some years ago to a special graduating class in mechanical drawing, one of the guests—an engineer of national repute—spoke to the following effect:

"Don't be afraid of using the English language on your drawings; don't be stingy in the use of notes. Remember that the man in the shop is not a mind reader, and a brief note, carefully worded, will often save the shop much uneasiness. The majority of draftsmen seem to think it a sign of weakness to resort to writing, and go out of their way to avoid notes. I assure you it is not only legitimate, but absolutely necessary to make use of notes if you are to become master draftsmen. But whatever you do, word them carefully, and don't forget to indent your paragraphs; and remember that an ambiguous note is worse than none at all. Don't speak of the right-hand side of a piece, or the front or the back; mark the particular side with a reference letter; you see the man in the shop when looking at the piece may be standing on the other side of it; then what was right to you is left to him, and that may cause trouble."

A LOW-COST CONCRETE CULVERT.*

By W. H. Whorley.†

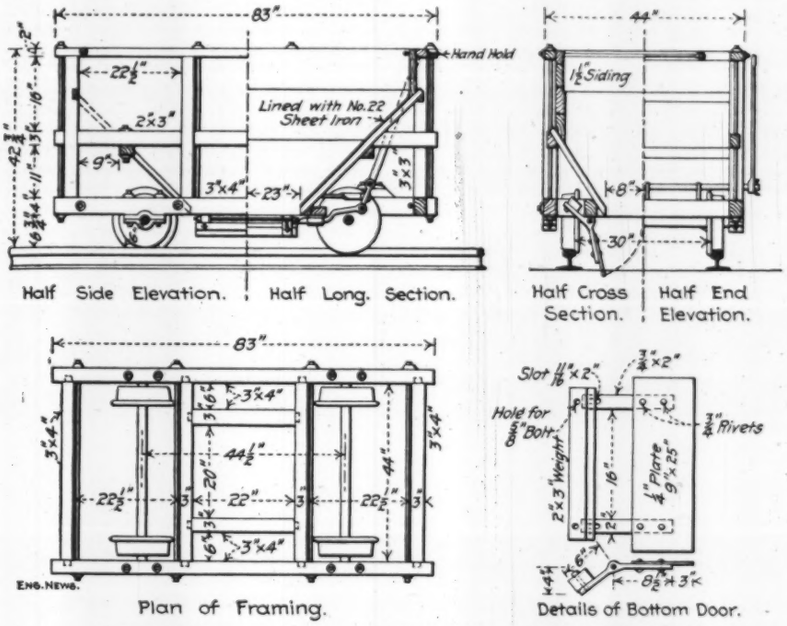
In line with the policy of the Nashville, Chattanooga and St. Louis Ry. to fill all trestles instead of rebuilding them, whenever possible to construct culverts for the waterway required, it was decided at the beginning of the present fiscal year to fill Trestle No. 55.7 on the Nashville Division. This trestle, which is known locally as Yellow Bank Trestle, has a total length of 922 ft. with the track at an elevation of 76 ft. above the valley. There is no stream under the trestle except during the wet season when a large volume of water passes through the valley.

After making a survey of the drainage area above the trestle to determine the size of waterway required, a 12-ft. full-centered concrete arch culvert with 6-ft. side walls was decided upon as being ample, and plans were prepared for the same.

In designing the lay-out of the plant for building the culvert advantage was taken of the height of track above the valley, so that as nearly as possible all material moved by gravity from the cars in which it was shipped until finally placed in position in the wall. Slag and sand were shipped in drop-bottom cars and unloaded into bins constructed in the trestle. These bins were built with hopper bottoms ending in chutes that led to a wheeling platform, which occupied the space between two of the trestle bents and extended over a concrete mixer placed just outside of the trestle. The slag bin was equipped with two chutes and the sand bin with one, so that all material for one batch could be loaded at the same time. A cement house was erected alongside the trestle at the wheeling platform, level with and adjoining the platform. An inclined chute led up from the opposite end of the cement house to an unloading platform at track level, so that the cement, which was shipped in sacks, could be handled directly from the cars to the chute, and thence by gravity into the house. The sand and slag were fed by gravity into wheelbarrows through gates controlled by levers to regulate the amount taken, and were then dumped into a hopper directly above the mixer. Two men wheeled slag to the mixer, one man wheeled sand, and one man wheeled cement. With the mixer in operation the wheeling platform became a busy place, as these men had to load the barrows and make a round trip, including dumping the load into the hopper in about one minute's time. The maximum wheeling distance from the chute to the hopper was 23 ft.

*A paper presented before the Engineering Association of the South, Jan. 13, 1906.

†Principal Assistant Engineer; Nashville, Chattanooga & St. Louis Ry.



A DROP-BOTTOM CAR FOR CONCRETE WORK, 1 CU. YD. CAPACITY.

Nashville, Chattanooga & St. Louis Ry.

A water supply was secured by sinking a well in the drainage channel just below the trestle, the water from this well being pumped by means of a gasoline engine into a tank placed on the trestle. From the tank a continuous stream of water was fed into the mixer through a flexible connection, a valve so regulating the flow that the necessary amount was delivered in the time required to mix a batch.

A drop-bottom car (see cut) of 1 cu. yd. capacity, running on 30-in. gage tram tracks, conveyed all concrete from the mixer to the wall. The hinged bottom doors of this car were held closed with a latch, which was withdrawn by means of a lever at the side of the car to dump the load. After dumping, the bottom doors closed automatically, and were latched by the lever above referred to. A trestle spanning the entire culvert, with the deck at a sufficient height to clear the top of the arch when completed, was constructed out of old car sills, and longitudinal tracks were built on the same directly above each wall, two small turntables connecting the longitudinal tracks with a cross track that extended to the mixer. This arrangement permitted dumping the concrete into its final position in the wall without rehandling. After reaching a point 2 ft. above the spring line, one of the tracks was removed and the other shifted to a position directly above the center of the arch, so as to reduce the handling of concrete to a minimum. Three men were required to handle the car, and they made the round trip when going to the extreme end of the culvert in about three minutes, the mixer in the meantime discharging into a small hopper, which discharged into the car upon its return.

The concrete consisted of a 1-3-6 mixture, slag and stone being used as the aggregate. It was intended to use slag exclusively, but delays in shipment of the same necessitated substituting stone for about one-third of the work.

All excavating for the foundation, unloading of material, mixing and placing of the concrete, was done by one of the regular concrete forces of the railway, consisting of 4 white men and 13 negroes, the rate of pay being as follows:

1 foreman, white	$3.50
1 mason, white	3.50
1 carpenter, white	2.25
1 blacksmith, white	2.05
5 laborers, black, at $1.20	6.00
8 laborers, black, at $1.10	8.80
Total	$26.10

Usually this gang builds the forms as well as doing all other work; but owing to the size of the culvert and the haste to complete concreting before cold weather, the forms, arch centering, bins, tram trestle and working platforms were erected by a bridge crew of white men, whose pay ranged from $1.75 to $2.25 per day. This slightly increased the cost of building forms, but secured rapidity of construction of the culvert.

The concrete gang moved to the work on September 12 last, excavated 853 cu. yds. of earth, unloaded the material for and mixed and placed 1,217 cu. yds. of concrete, removed the forms and bins, loaded all timber used in construction, etc., and moved away on November 9. During this time they lost three days on account of rain and closed down one day for lack of material. The mixer was in operation 194 hours, and mixed 7,702 batches, or at the rate of 1 batch every 87 seconds during the entire time it was in operation. During the last 10 days it mixed a batch every 78 seconds while running. The best short record made was 291 batches in five hours, being 1 batch every 63 seconds, or at the rate of 58 batches, equal to 9.2 cu. yds. of concrete in place per hour. This is about equal to the capacity of the machine, one-half minute being required to mix the concrete, and at least that much time is consumed in charging and discharging it. A No. 5 Chicago improved cube mixer, operated by a Bates & Edmunds Motor Co. gasoline engine, was used, and gave satisfaction; but a larger size would have been more economical, as all cement had to be measured, which required an additional man, the amount required for each batch being two-thirds of a sack. Another objectionable feature of the small machine was the size of the charging hopper, which caused a tendency to choke if the entire contents of a wheelbarrow was dumped into it at once. One man was required, therefore, to keep the hopper open, thus causing a delay in charging the mixer, which materially reduced the daily output of the same.

For the purpose of comparing the cost of this culvert with that of others built by the railway, I have taken from the tables accompanying the paper of Mr. H. M. Jones on "Concrete and Concrete Costs," submitted to the Engineering Association of the South in October, 1904, four examples of culverts approximating the conditions existing at Yellow Bank, and have compiled with them the costs of this work. Table No. 1 gives the total cost of each of the structures, while in Table No. 2 is shown the cost of concrete work proper. An inspection of Table No. 1 shows that the labor cost at Yellow Bank is only 58% of the labor cost at the Doe Creek culvert, McMinnville Branch, the cheapest of the other culverts; while the material cost is nearly the same, the reduction being mainly the difference between the cost of slag used at Yellow Bank and of crushed stone used at the other place. The reduction in labor cost is due largely to the use of a mechanical mixer, although the large yardage and the economical methods employed in handling material were factors in bringing about this reduction.

OPEN AIR ELEVATORS have been built at Valetta, Malta, to connect the shipping wharves with the upper portion of the town. The steel framework is built against the face of a cliff and has a height of about 170 ft. The main driving sheaves are driven by worm gearing from 12-HP. motors using 500-volt current. Separate motors operate the brakes. At each end of the trip the car is brought to rest by means of hydraulic buffers upon which the car or its counterbalance take a bearing as they reach the bottom of the shaft. At the same time the current is shut off and the brakes are applied automatically. The elevators, which are for passengers and baggage only, were built by Joseph Richmond & Co., of London, England.

TABLE I. STATEMENT OF COST OF CERTAIN CONCRETE STRUCTURES

	Name of Structure				
	16 ft. Culv. No. 25.5, Nashville Division.	12 ft. Culv. No. 133.3, Chattanooga Division.	12 ft. Culv. Doe Creek, McMinnville Br.	10 ft. Culv. No. 1.0, P. & M. Division.	12 ft. Culv. No. 55.7, Nashville Division.
Labor Costs:					
Cubic yards	986	292	406	354	1,217
Excavation	$639.05	131.15	140.50	212.20	345.52
Unloading material	.....	$54.00	65.15	63.70	139.81
Building forms	$407.70	136.80	295.20	217.80	665.91
Mixing and placing	$1,240.75	396.05	495.70	597.10	506.15
Back-filling and tearing down molds	$262.85	148.80	186.25	111.45	128.02
Not classified	$360.25	.....	.....	45.85	214.22
Totals:					
Labor	$2,910.60	$866.80	1,132.80	1,248.10	1,999.63
Average per yard	$2.97	2.97	2.97	3.53	1.74
Material:					
Cement, Sacks	3,749	1,179	1,611	1,512	5,168
Value	$1,986.95	532.05	853.85	801.35	2,248.08
Sand, Cubic yards	468	134	188	158	576
Value	$140.40	53.60	75.20	63.20	172.80
Stone, Cubic yards	936	260	375	333	280
Value	$567.80	156.00	187.50	166.50	168.00
Slag, Cubic yards	.....	.....	.....	.....	945
Value	.....	.....	.....	.....	245 70
Lumber, Value	$543.35	125.00	121.50	167.05	362.62
Miscellaneous	$30.00	15.00	77.15	.....	61.30
Totals:					
Material	$3,268.50	866.65	1,253.05	1,275.25	3,258.50
Average per yard	$3.30	2.96	3.09	3.60	2.63
Grand Total:					
Labor and Material	$6,179.10	1,733.25	2,385.85	2,523.35	5,258.13
Average per yard	$6.27	5 93	5.88	7.13	4.32

TABLE II. SHOWING COST OF CONCRETE WORK PROPER IN CERTAIN STRUCTURES.

	Name of Structure				
	16 ft. Culv. No. 25.5, Nashville Division.	12 ft. Culv. No. 133.3, Chattanooga Division	12 ft. Culv. Doe Creek, McMinnville Br.	10 ft. Culv. No. 1.0, P & M. Division.	12 ft. Culv. No. 55.7, Nashville Division.
Labor Costs:					
Cubic yards	986	292	406	354	1,217
Unloading material, Cost	.....	$54.00	65.15	63.70	139.81
Per yard	.....	.18	.16	.18	.11
Building forms, Cost	$407.70	136.80	295.20	217.80	665.91
Per yard	.41	.47	.73	.61	.55
Mixing and placing, Cost	$1,240.75	396.05	495.70	597.10	506.15
Per yard	$1.26	1.35	1.22	1.69	.42
Total:					
Labor	$1,648.45	586.85	856.05	878.60	1,311.87
Per yard	$1.67	2.00	2.11	2.48	1.08
Material Costs:					
Cement, Value	$1,986.95	532.05	853.85	801.35	2,248.08
Per yard	$2.02	1.82	2.10	2.26	1.85
Sand, Value	140.40	53.60	75.20	63.20	172 80
Per yard	$0.14	.18	.19	.18	.14
Stone or slag, Value	$567.80	156.00	187.50	166.50	413.70
Per yard	$0.58	.53	.46	.47	.34
Lumber, Value	$543.35	125.00	121.50	196.05	362.62
Per yard	$0.55	.43	.30	.47	.30
Total, material	$3,238.50	866.65	1,238.05	1,198.10	3,197 20
Per yard	$3.29	2.96	3.05	3.38	2.63
Grand total:					
Labor and material	$4,886.95	1,453.50	2,094.10	2,076.70	4,509.07
Average per yard	$4.96	4.97	5.16	5.86	3.71

WATER FAMINE AND TYPHOID IN CINCINNATI.

By Ward Baldwin, M. Am. Soc. C. E.*

An understanding of the causes that led to the so-called "water famine" in certain parts of Cincinnati during the week June 3 to June 10 of this month and year, can only be had by one who has a general knowledge of what may be termed the hydraulic topography of the Cincinnati Water-works.

The facts are of absorbing interest to the local sufferers and of general interest to water-works managers, but have apparently been of too technical or varied a character to be successfully correlated by the local press, which has indulged in much speculation, and finally laid the burden of responsibility on a very worthy official without having illumined the causes of what has been a rather remarkable situation.

PRESENT CONDITION OF WATER SUPPLY.

Cincinnati has two reservoirs, the "Third Street Reservoir," or low-service reservoir, supplied by two six million gallon pumps; and the "Eden Park Reservoir," or middle service reservoir, supplied by six pumps having an aggregate capacity of about 50 million gallons and five direct-acting auxiliary pumps of an aggregate capacity of about 8 million gallons.

The low-service district, which is supplied from the Third Street Reservoir, comprises a comparatively small area, largely occupied by business houses, and is sometimes designated as the business district. The water mains in this district do not form an independent system, but are continuous with the water mains in the rest of the city, and the separation of the low service mains from the other mains is effected by means of so-called division valves that are usually kept closed.

The middle-service district, which is supplied from the Eden Park Reservoir, comprises a large part of the upper business district and also a large part of the suburbs. The water mains in this district are separated from the low-service and high-service districts by "division valves" in the mains, which, as before stated, form a continuous system throughout all parts of the city.

The high-service district, which comprises the suburban hills and all territory too high to be supplied by the middle service, is supplied by five different sub-pumping stations designated respectively as the Mt. Auburn Service, Eden Park Service, Price Hill Service, Cumminsville Service and Westwood Service, all drawing water from the Eden Park Reservoir.

The Eden Park Station draws water directly from the Eden Park Reservoir basins and delivers into a stand pipe located in Eden Park. There are three pumps at this station having an aggregate capacity of about 16 million gallons. The other four high-service sub-stations draw water from the feeder mains running from the Eden Park Reservoir and deliver into stand pipes. The aggregate capacity of the pumps at these four stations is about 14 million gallons. There is also a small sub-station at Linwood drawing water from deep wells, but this station pumps less than 1% of the total water of the city and is of no importance.

About 85% of the water supply of the city is delivered to the Eden Park Reservoir and is distributed from there, and about 15% of the water supply of the city is delivered to the Third Street Reservoir. Under normal conditions the water from these two reservoirs is kept separate by means of "division valves" in the mains.

The above description applies to the so-called "Old Water-works" of Cincinnati, but there is now nearing completion the "New Water-works."* When this new system is completed, all the present pumping stations and the Third Street Reservoir will be abandoned. The new system consists of a low-service station at California, about five miles above the city, where water will be pumped from the Ohio River into subsiding reservoirs and filtered; a main pumping station at Columbia, which receives filtered water from the low-service station through a gravity conduit and delivers it through three 25 million gallon pumps directly into the service mains of the present low-service and middle-service districts and into the Eden Park Reservoir, which will receive the overflow and thus serve to equalize the work required of the pumps; a substation in the western part of the city, where water will be pumped from the mains supplied by the Columbia station and delivered to the western hill tops, which are higher than the district supplied by the high-service pumps at the main station. In connection with the new system, there is to be laid a system of new feeder mains to provide a greater supply where the old mains are inadequate. These new mains have been partly laid, and some of them have already been connected to the old mains in the western part of the city, while other parts of the system of new mains have not yet been connected to the old mains, and will be of no service until so connected or until the new pumping stations are put in operation.

The consumption of water has increased rapidly in the past few years, both on account of the normal growth of the city and also on account of the annexation of a number of the suburban villages, but on account of the expected early completion of the "New Water-works," the "Old Water-works," both its distributing mains and its pumps, has been allowed to stand without material betterment, and both mains and machinery are now and have for several years been inadequate to meet the demands for water, especially in summer weather. As a temporary expedient, five direct-acting so-called auxiliary pumps, with an aggregate capacity of about eight million gallons, have been installed at the Front St. station on the river bank. The combined storage capacity of the present Third Street and Eden Park Reservoirs is about 105 million gallons. The estimated capacity of the pumps, including the auxiliaries at the Front St. station, where all the water supply is pumped from the river, is about 58 million gallons, but one of the 12 million gallon pumps has been out of service for some months undergoing repairs, thus reducing the total capacity to about 46 million gallons.

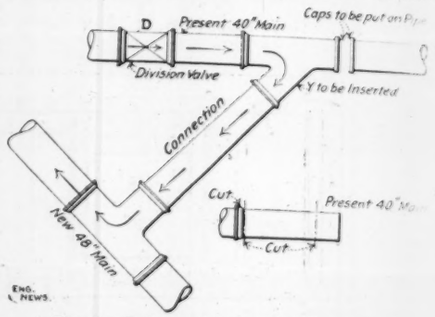


Fig. 3. Details of Attempted Connection.

The pumps have, however, had to be run continuously without repairs for so long a time that the plunger packing is badly worn, and the valves are in bad condition. The slippage is consequently estimated at from 25 to 30%.

The maximum daily consumption at times reaches about 70 million gallons. It has, therefore, been necessary to restrict the use of water during the summer for several years, and it has only been possible to maintain a supply by the exercise of the strictest economy.

THE FAMINE.

On Sunday, June 3, it was proposed to connect one of the 48-in. mains of the "New Water-works" with a 40-in. main of the "Old Water-works" at Eighth St. and Eggleston Ave., at the point marked "A" in Fig. 1. The purpose of this connection was to give the middle district a better supply through the new 48-in. main which runs east and west through the "middle-service" district. The 48-in. main of the "New Water-works" is shown by a broken line on Ninth St. and on Eggleston Ave. At this place there is a 40-in. main on Eighth St., east of Eggleston Ave., bringing water from the Third St. or low-service reservoir, and containing a "Division Valve" at "D." This is connected to a 48-in. main running west from Eggleston Ave. on Eighth St. There is a 36-in. main on Cleveland St. bringing water from the Eden Park or middle-service reservoir. This water is prevented from running east on Eighth St. in the 40-in. main by the Division Valve "D," which is intended to be kept closed, but the 36-in. main supplies the 48-in. main running west on Eighth St. There is a 20-in. main branching out of the 36-in. middle-service main and running southwest on Eggleston Ave., with a valve at "H."

In attempting to make the connection at "A," the valve "D" was supposed to be shut and was not turned. A valve at the Third Street Reservoir on the 40-in. main was closed and two 20-in. valves on the 20-in. main leading from the Third Street Reservoir and marked "K" and "M" on Fig. 2 were also closed.

The connection was to be made with a Y, as shown in Fig. 3, the 40-in. main and the contiguous end of the Y were to be capped, the valve "D" was to be opened, and the water from the 36-in. middle-service main would then pass into the new 48-in. main, as shown by the arrow in Fig. 3. It is said that, while this connection would give some improvement in the distribution, the purpose of making it at this time was also to enable the new main to be tested and accepted as provided for in the contract for the new main.

The present 40-in. main was partly cut through in two places, and a piece was cut out of the

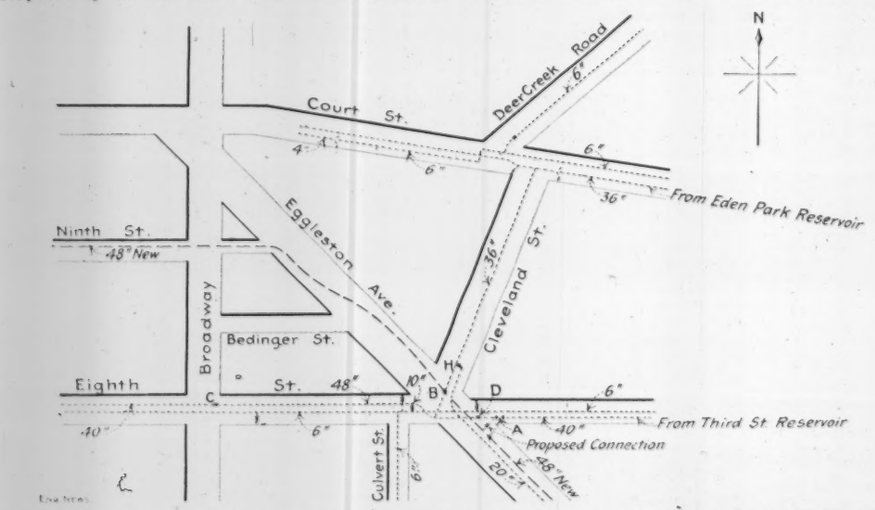


FIG. 1. CORNER OF EIGHTH ST. AND EGGLESTON AVE., CINCINNATI, SHOWING LOCATION OF ATTEMPTED CONNECTION OF 40-IN. AND 48-IN. MAINS.

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*See Eng. News, Vol. Jan.-June, 1900, p. 270.

hub. Water at high pressure rushed out of this opening in the hub end and ran for several hours with no apparent decrease of pressure. An effort was now made to close valve "B," as it was concluded that valve "D" was not tight. Valve "B" is geared and the gears, it was afterwards discovered, had become clogged with dirt. This valve moved hard and after it was partly closed, eight men with crow bars for levers in trying to force it to work twisted the valve stem off. This valve is in this condition to-day, and it is proposed to put in a by-pass around this valve, making the connection of the by-pass and the 36-in. main with Smith connections. Valve "C" on the 48-in. main at Eighth St. and Broadway and other valves on the 36-in. main, between Cleveland St. and the Eden Park Reservoir, were then closed without causing any reduction in the pressure at the cut pipe at "A."

The pumps supplying the middle-service district were unable to make up for the loss of supply caused by shutting down the two 6 million gallon low-service pumps, and the water level in the Eden Park Reservoir fell rapidly, and within a few days was so low that the substation pumps in the Eden Park high-service station could not draw water and had to be shut down, thus reducing the capacity of the high-service supply about 16 million gallons. The lowering of the water in Eden Park and the draining from the middle-service into the low-service mains reduced the pressure in the middle-service mains, which also form the suction mains for the sub-station pumps, and these pumps were, therefore, delivering less water than usual. It appears that the quantity they pumped was not sufficient to supply the consumption along the line of the mains between the pumps and the stand pipes, as the latter were empty from Friday, June 8, till the night of Sunday, June 10, at which time all the valves were changed back to their original condition.

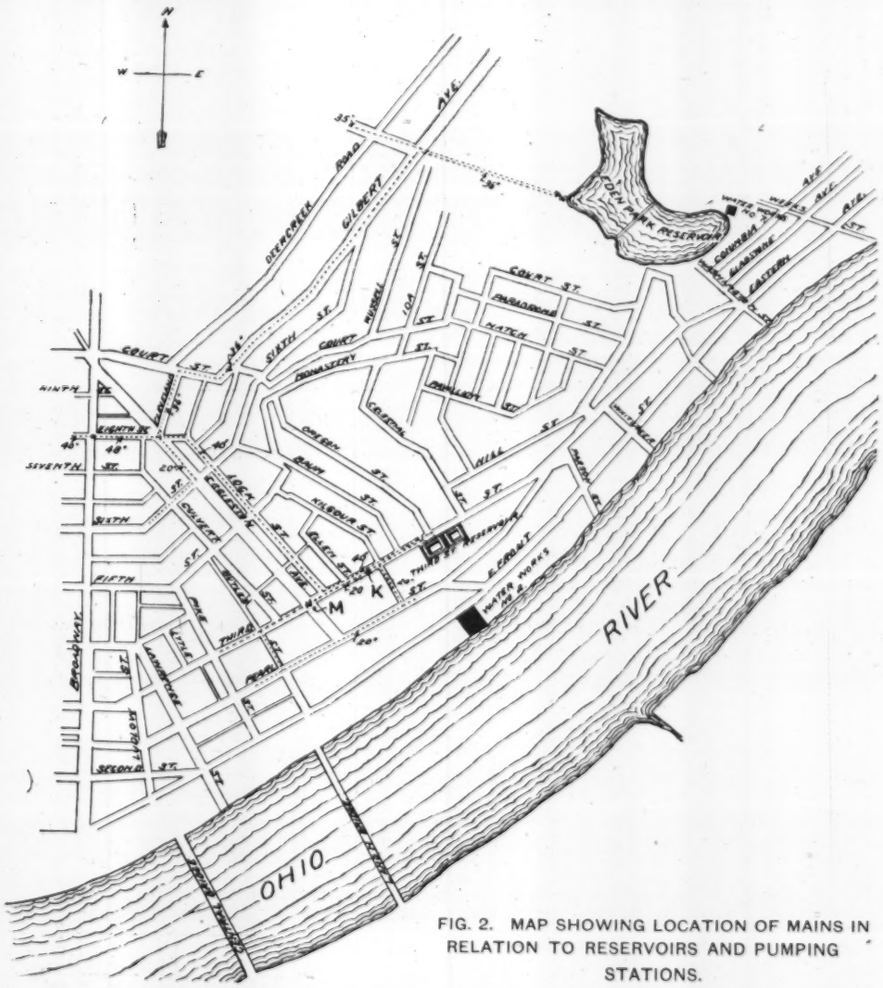

FIG. 2. MAP SHOWING LOCATION OF MAINS IN RELATION TO RESERVOIRS AND PUMPING STATIONS.

It was then decided not to make the connection at "A." The cuts and bell were banded with wrought bands, a split sleeve was put on to cover the bands and the valves were, as far as possible, restored to their former condition as to being open or shut. This work consumed several days and was completed on June 10.

Meanwhile, when the valve on the 40-in. main at the Third St. Reservoir and the 20-in. valves "K" and "M" were closed, one or more division valves between the middle and low-service districts were opened in order to supply the deficiency in the low district (due to closing said valves in the 40-in. and 20-in. low service mains) with water from the middle district. The Third St. Reservoir was filled with water drawn from the middle district and the pumps delivering water to the Third St. Reservoir were shut down. This was done, as nearly as can be ascertained, on Sunday, June 3.

For several days all the high-service district was without water, and there was a threatened shut down of all factories, power plants, street car lines, electric light stations, etc.; but this was not done. There was much discomfort due to the lack of water in suburban residences, and in the hill-top hospitals. A meager supply was furnished in these places from the 8th to the 10th inst. by hauling water in sprinkling carts and pumping from fire cisterns with fire engines.

The facts summarized seem to be that there was no abnormal scarcity of water on June 3. Certain division valves opened on that date allowed water to flow from the middle-service mains into the low-service reservoir and mains. The low-service pumps were shut down. The middle-service pumps were inadequate to pump enough water to keep the Eden Park Reservoir filled, and the supply on the hill tops failed until the division valves were closed on June 10.

TYPHOID.

There has been for several weeks a great deal of typhoid in Cincinnati, the cases numbering from 80 to 100 per week. The causes are not far to seek. The source of the present water supply is in the Ohio River, within the city limits. Above the Front St. pumping station more than 4½ miles of built up territory extends to the easterly corporation line, from which considerable of the sewage and all surface drainage is discharged into the river above the pumping station. Upon the Kentucky side of the river all of the towns of Dayton and Bellevue and part of the city of Newport, opposite the easterly portion of Cincinnati, sewer and drain into the Ohio River above the pumping station. Above the pumping station is the mouth of the Little Miami River, the valley of which contains many populous towns discharging their sewage into the Miami. The Ohio River before it reaches Cincinnati received the sewage and surface drainage from cities having an aggregate population of nearly two million. These conditions were fully described in the report on the Extension and Betterment of the Cincinnati Water-works by the Engineer Commission in 1896, and the bad sanitary condition of the present supply has led the city to build the new system, which will soon be completed and in operation, and which will be free from the unsanitary conditions that make the present supply a source of zymotic disease.

OPERATING EXPENSES OF A SINGLE-PHASE INTERURBAN RAILWAY.

The results of operation of the single-phase line of the Bloomington, Pontiac & Joliet Electric Ry. have recently been given by Mr. J. R. Hewett in an article in the "Street Railway Journal," and show a generally satisfactory experience. This railway was described in our issues of March 30 and April 5, 1905, and now has 19 miles in operation between Pontiac and Dwight, Ill., but the figures given relate to the operation of the 10.4 miles between Pontiac and Odell for the last nine months of 1905. The trolley voltage is 3,300, and there are no substations; the power is purchased, so that no figures of cost of power station operation are involved. The cars weigh 32 tons and have an average schedule speed of 21 miles an hour, while the amount of current per car-mile averages 2.1 kilowatt-hours. The car equipment has been very satisfactory, not a single armature or field coil has been burned out, and there has been no trouble with the brushes, although the brush-holder studs have been somewhat troublesome; the life of the brushes is from 10,000 to 12,000 miles. The trolley wheels have a life of about 3,000 miles. The figures given by Mr. Hewett are tabulated below, in condensed form:

	Cts. per car-mile.
1. Maintenance Expenses:	
Track and roadway	0.31
Electric line	0.09
Electric power plant	0.091
Cars	0.195
Electric equipment of cars	0.30
Miscellaneous shop expenses	0.016
Total maintenance expenses	1.312
2. Transportation:	
Power	5.925
Wages of conductors and motormen	3.70
Wages of other car service employees	0.645
Wages of car house employees	0.135
Car service supplies	0.67
Miscellaneous car service expenses	0.705
Bus transfers	0.475
Total transportation expenses	12.285
3. Miscellaneous (salaries, office, advertising, damages, insurance, etc.)	2.345
Summary of Operating Expenses:	
1. Maintenance	1.312
2. Transportation	12.285
3. Miscellaneous	2.345
Total cost of operation per car-mile	15.942

Ave. mileage per car per day	167.2 miles
Ave. watt-hours per car-mile	2,100 W-H
Ave. watt-hours per ton-mile	73.5 W-H
Earnings per car-mile	23.1 cts.
Ratio of op. exp. to gross receipts	69.0%
Weight of cars	32 tons
Speed, schedule, 21; maximum	44 miles per hour

TENSION-TESTS OF STEEL ANGLES WITH VARIOUS TYPES OF END-CONNECTION.*

By Frank P. McKibben.†

The tension-tests which form the subject of this paper were made in the testing laboratory of the Massachusetts Institute of Technology upon 27 specimens of rolled steel angles such as are used for tension members in riveted structural work. They were made with a view of studying the following points:

1. The ultimate strength of the angles in tension.
2. The value of a lug in transmitting stress from the outstanding leg of the main angle into the hitch plate.
3. The relative strength of angles where the gage-line for rivets and where the center of-gravity line, respectively, pass through the center of the pull.
4. The relative strength of single angles and angles riveted together to form pairs.

There are three specimens of each of nine different types, making in all 27 specimens. These are shown in detail in Fig. 1. Each of the main angles, 5 ft. 4 ins. in length, is riveted at each end to a hitch plate.

Types A_1, B_1 and C_1 consist each of one angle, $3\frac{1}{2} \times 3 \times \frac{5}{16}$ in., $4 \times 3 \times \frac{5}{16}$ in. and $6 \times 4 \times \frac{5}{16}$ in., respectively, riveted to the hitch plates by one leg only.

Types A_2, B_2 and C_2 consist each of one angle of the same size as A_1, B_1 and C_1, respectively, and have both legs connected to the hitch plates, the outstanding leg being connected by means of a lug angle.

Types D_1 and D_2 each is made up of two $3 \times 3 \times \frac{5}{16}$-in. angles, one on either side of the hitch plate. D_1 is not, and D_2 is, provided with lugs for each of the outstanding legs of the main angles.

In each of the types just mentioned the gage line for rivets in the main angle is run through the center line of pull. In the case of angles with unequal legs the long leg is placed in contact with the hitch plates.

Type B_3 consists of one $4 \times 3 \times \frac{5}{16}$-in. angle connected to the hitch plates by one leg only. It differs from type B_1 in that the line of pull coincides with a projection of the center of gravity line instead of with the gage line for rivets.

The end connections were designed to insure failure in the main angles, and the specimens were made as long as could be tested conveniently. The hitch plate at each end of each specimen was provided with two 2-in. holes, by means of which it was pinned between two holding plates fastened in turn by a single pin to a third plate gripped by the testing machine. A diagram of this holding device is shown in Fig. 2.

All of the pieces of angles of a given size were cut from one long angle, and from each of these long pieces there were also made two small tensile test specimens. Table I. gives the average results of the tensile tests on the small specimens which were approximately $18 \times 1\frac{1}{2} \times \frac{5}{16}$ or $\frac{5}{16}$ in. in size.

Fig. 3 shows diagrammatically the outlines of the various fractures, all of which occurred in the main angles. There was no failure of rivets. The numbers on the sketches show the sequence of the fractures. With the exception of one of the specimens, made of two $3 \times 3 \times \frac{5}{16}$-in. angles, failure took place at one of the inner rivets which connects the angle to the hitch plate, that is, the connecting rivet which lies nearest the center of the specimen. In the case of the exception noted, rupture occurred at the center of the specimen where there is a single rivet connecting the two angles together. In all cases just before failure the metal between the inner rivet and the outer edge of the leg connected by that rivet to the hitch plate, drew down considerably at both ends of the specimen. Failure then occurred at this point, continuing slowly across the horizontal leg and then up the vertical leg. With the one exception cited, failure occurred, in all specimens having lugs, on a zig-zag section passing through rivets in the horizontal and in the vertical legs. In order to secure the greatest strength from an angle in tension this zig-zag section should be equal to or greater than the net right section. In none of the specimens tested is this the case. Consequently the total ultimate strength of some of the specimens with lugs is less than that of similar specimens without the lugs. However, the strength per square inch of net area is greater where the lugs are provided, showing that with the proper spacing of rivets to utilize the maximum net area the lug is an advantage.

Table II shows in detail the results of the tests. Table III shows the percent increase in the strength per square inch of net area due to the lugs.

The results of the tests show that the ultimate strength per square inch of net section for angles having gage lines for rivets passing through the center of pull varies, for the single angles, from 39,800 to 51,500 lbs., which is

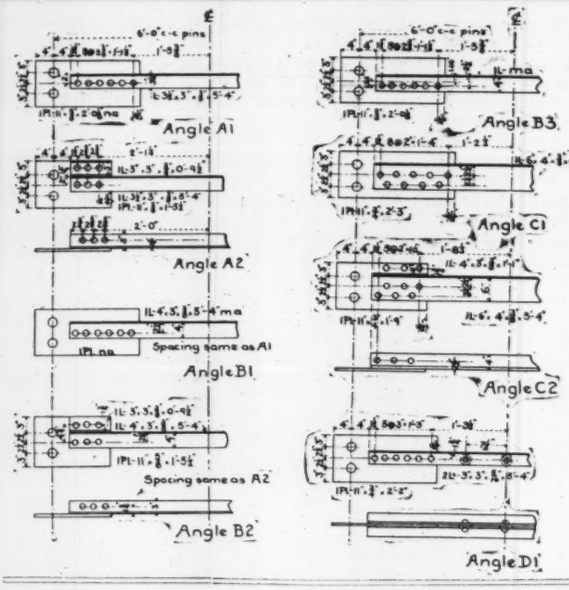

FIG. 1. TENSION TESTS OF STEEL ANGLES.—NINE TYPES OF END-CONNECTION TESTED.

Note: All angles had both ends alike. All angles 5 ft. 4 ins. in length. Rivets $\frac{7}{8}$-in.; holes punched $\frac{15}{16}$-in. Pin holes 2-in. diameter drilled.

TABLE I.—TENSILE STRENGTH OF SMALL TEST SPECIMENS CUT FROM STEEL ANGLES.

Size of angle from which specimen was cut.	$3\frac{1}{2} \times 3 \times \frac{5}{16}$ in.	$4 \times 3 \times \frac{5}{16}$ in.	$6 \times 4 \times \frac{5}{16}$ in.	$3 \times 3 \times \frac{5}{16}$ in.
Yield point, lbs. per sq. in.	33,160	31,600	32,600	34,800
Ultimate strength, lbs. per sq. in.	59,300	54,000	51,600	61,000
Elongation, per cent in 8 ins.	28.0	28.6	31.1	29.5
Reduction of area, per cent.	48.9	54.6	56.5	52.6
Appearance of fracture.	Silky	Silky	Silky	Silky

TABLE II.—SUMMARY OF TENSION-TESTS ON STEEL ANGLES.

Type.	No. of Specimens.	Nominal Size.	Cross Section — Area in square inches. Nominal.	Actual gross.	Net.	Breaking Load — Lbs. Total.	Per sq. in. of net area.	Per cent. Strength of Material Developed.*	Remarks.
A_1	1	$3\frac{1}{2} \times 3 \times \frac{5}{16}$	2.30	2.29	1.95	89,500	45,900	77.4	Without lugs
"	2	"	"	2.32	1.98	96,100	48,500	81.8	
"	3	"	"	2.35	2.00	95,200	47,600	80.2	
"	Mean	"	"	2.32	1.98	93,600	47,400	79.8	
A_2	4	$3\frac{1}{2} \times 3 \times \frac{5}{16}$	"	2.28	1.78	84,600	47,500	80.1	
"	5	"	"	2.28	1.78	88,600	49,800	84.0	With lugs
"	6	"	"	2.27	1.77	91,200	51,500	86.8	
"	Mean	"	"	2.28	1.78	88,100	49,600	83.6	
B_1	7	$4 \times 3 \times \frac{5}{16}$	2.49	2.44	2.10	85,000	40,500	75.0	
"	8	"	"	2.42	2.09	84,000	40,100	74.3	Without lugs
"	9	"	"	2.50	2.15	85,600	39,800	73.7	
"	Mean	"	"	2.45	2.11	84,900	40,100	74.3	
B_2	10	$4 \times 3 \times \frac{5}{16}$	"	2.42	1.92	83,500	43,500	80.5	
"	11	"	"	2.43	1.92	85,100	44,300	82.0	With lugs
"	12	"	"	2.45	1.95	84,100	43,100	79.9	
"	Mean	"	"	2.43	1.93	84,200	43,600	80.8	
B_3	13	$4 \times 3 \times \frac{5}{16}$	"	2.41	2.07	88,600	42,800	79.3	
"	14	"	"	2.42	2.09	90,400	43,200	80.0	Centre of gravity line through pull
"	15	"	"	2.41	2.07	91,000	44,000	81.4	
"	Mean	"	"	2.41	2.08	90,000	43,300	80.2	
C_1	16	$6 \times 4 \times \frac{5}{16}$	3.61	3.53	3.11	131,000	42,100	81.6	
"	17	"	"	3.54	3.12	125,700	40,300	78.1	Without lugs
"	18	"	"	3.50	3.07	128,200	41,800	81.1	
"	Mean	"	"	3.52	3.10	128,300	41,400	80.3	
C_2	19	$6 \times 4 \times \frac{5}{16}$	"	3.50	3.04	131,500	43,300	84.0	
"	20	"	"	3.50	3.03	130,200	42,900	83.2	With lugs
"	21	"	"	3.50	3.04	131,900	43,400	84.1	
"	Mean	"	"	3.50	3.04	131,200	43,200	83.7	
D_1	22	Two $3 \times 3 \times \frac{5}{16}$	3.56	3.44	2.88	134,100	46,600	76.4	
"	23	"	"	3.43	2.87	136,500	47,700	78.3	Without lugs
"	24	"	"	3.49	2.91	139,100	47,800	78.4	
"	Mean	"	"	3.45	2.89	136,600	47,400	77.7	
D_2	25	Two $3 \times 3 \times \frac{5}{16}$	"	3.43	2.69	137,900	51,200	84.0	
"	26	"	"	3.43	2.69	140,400	52,200	85.6	With lugs
"	27	"	"	3.42	2.86	138,800	48,500	79.6	
"	Mean	"	"	3.43	2.75	139,000	50,600	83.1	

*Figures of previous column compared with specimen tensile test results of Table I.

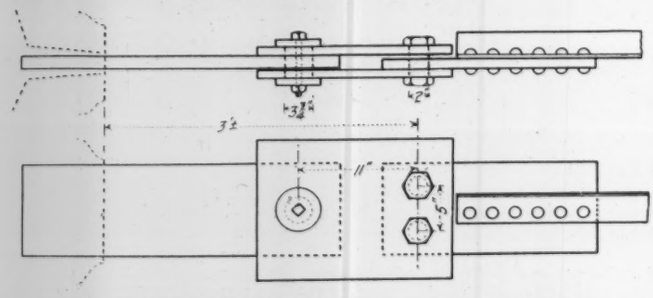

FIG. 2. TENSION RIGGING FOR TESTS OF STEEL ANGLES.

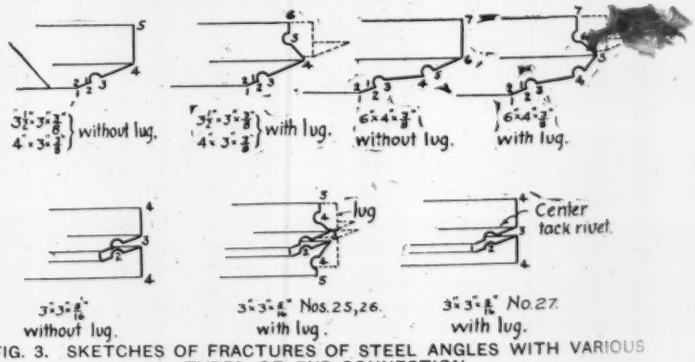

FIG. 3. SKETCHES OF FRACTURES OF STEEL ANGLES WITH VARIOUS TYPES OF END-CONNECTION.

[Small figures at fracture indicate origin and progress of rupture.]

*A paper read before the American Society for Testing Materials at Atlantic City, N. J., June 23, 1906.

†Assistant Professor of Civil Engineering, Massachusetts Institute of Technology, Boston, Mass.

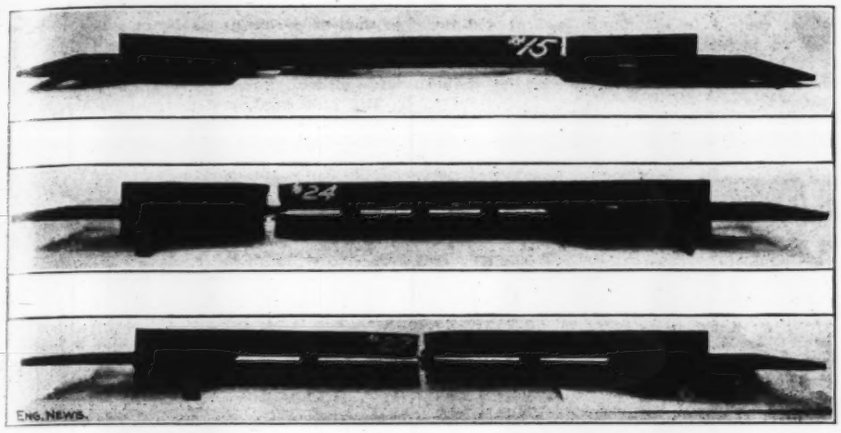

FIG. 4. VIEWS OF THREE OF THE TEST SPECIMENS AFTER FRACTURE.
[No. 27 was the only specimen which did not break at the end connection.]

approximately from 74% to 87% of the strength of the tensile test specimens; and for angles riveted together in pairs, from 46,600 to 52,200 lbs., which is approximately 77% to 86% of the strength of the material as developed by the tensile test specimens.

The efficiency of the lug is shown by the fact that for specimens provided with lugs there is an increase over specimens not so provided of from 4.7% to 8.7% in ultimate strength per square inch.

A study of the results of the 4 × 3 × ⅜-in. angles without lugs shows that there is a gain of 8% in the strength per square inch for specimens having the line of pull coinciding with the projection of the center of gravity line instead of the gage line for rivets. It further appears that for these angles the strength per square inch is practically the same for those specimens having the center of gravity connections *without* lugs as it is for those having the gage line connections *with* lugs.

TABLE III.—SHOWING VALUE OF LUGS.

Type.		Ultimate strength per square inch of net section.	Increase in strength per square inch of net area.
A_1	Without lug	47,400	—
A_2	With lug	49,600	4.7
B_1	Without lug	40,100	—
B_2	With lug	43,600	8.7
C_1	Without lug	41,400	—
C_2	With lug	43,200	4.4
D_1	Without lug	47,400	—
D_2	With lug	50,600	6.8

Notwithstanding the fact that the net as well as the gross area of the two 3 × 3 × 5/16-in. angles is less than in any of the single 6 × 4 × ⅜-in. specimens, yet the ultimate load carried by the former is greater in every case. This is no doubt largely due to the greater strength of the material in the double specimens on account of their smaller size and thickness.

In closing, the writer wishes to express his obligations to Messrs. Arthur L. Davis and S. P. Waldron, of the American Bridge Co., for the specimens tested, and to Messrs. A. F. Holmes, instructor, and C. T. Bartlett and H. P. Orcutt, students in the Massachusetts Institute of Technology, who carefully did the work in the laboratory.

SOME FEATURES OF THE PLANT OF THE WESTERN ELECTRIC CO., CHICAGO.

The Hawthorne plant of the Western Electric Co., at Chicago, is a modern and well equipped plant which includes not only shops for the manufacture of generators, motors and other electrical machinery and apparatus, but has also special shops for the manufacture of telephone and power cables, and for making the various rubber appliances used in telephone construction. This plant was described in some detail in a paper read recently before the Western Society of Engineers by Mr. H. R. King, and from this we take some particulars of the special features of the plant.

COAL STORAGE.—The most striking feature is the new cold storage system, in which the coal will be stored under water to protect it from deterioration due to atmospheric influences and from the possibility of spontaneous combustion. We have commented upon this in our editorial columns. The coal for the regular supply of the boilers is stored in a bunker of 1,000 tons capacity, from which it is discharged by spouts into a hopper-scale traveling on a track along the front of the bunker, so that coal can be taken from any part of the bunker and delivered to any boiler, as required. In view of the uncertainties of the coal supply, due to strikes, etc., the company has decided to adopt the system of storing coal in large quantities, and also to submerge this reserve coal in water to protect it from the action of the air. Two storage bins of 4,000 and 10,000 tons capacity have been built below the ground, into which coal may be dumped from cars, and from which it may be taken by a locomotive crane handling a grab bucket. This storage system provides a coal supply sufficient for four months in the winter season.

FIRE PROTECTION.—In the construction and equipment of the plant, special care was given to the question of fire prevention and fire protection, with the result that a large saving in insurance expenses has been effected. Most of the buildings are one story high, far enough apart to prevent danger of fire spreading, while large interior areas are divided by fire walls with double tin-clad doors at all openings. The walls are of brick, with wire-glass windows at exposed points; the floors are of concrete, sometimes covered with wood, and the roofs are of tile on structural steel. The plant is protected throughout by the automatic sprinkler system, except in the foundry, forge shop and main body of the machine shop, in which there is absolutely no combustible material. Each steel column supporting the roof of the machine shop has sprinkler heads 15 ft. above the floor, to protect the columns from the danger of fire around them. The sprinkler system is supplied by about 13,000 ft. of 10 and 12-in. pipe laid through the yards, the supply to each building being controlled by a gate valve with post indicator, so that the supply may be regulated without entering the building.

On the yard mains there are 45 hydrants, each protected by a wooden house containing nozzles, axes, lamps, etc. There are from 200 to 500 ft. of hose at each hydrant, and with 1,000 ft. of hose on the hose carts at the fire station there are about 6,000 ft. of 2½-in. fire hose. In the house adjoining the water tower are two 1,500-gallon underwriters' fire pumps, and the reservoir mentioned will supply both of these for 27 hours. There is also a liberal equipment of water pails, fire pails, chemical extinguishers, and about 4,500 ft. of small hose attached to the sprinkler system. The company maintains a fire department, the head of which devotes all his time to the apparatus and the training of his men, and during the day he has under him 16 men employed in departments near the fire house. At night there are nine watchmen under a captain. There are 47 fire alarm boxes.

For the water supply there is a reservoir of 5,000,000 gallons capacity, intended primarily for fire service, for which two fire pumps with a capacity of 1,500 gallons per minute are provided. This is also used to supply the condensing water for the power-house. In addition to the reservoir there is an ornamental tower containing six steel tanks with a total capacity of 213,000 gallons; these are connected with the sprinkler system, the bottom of the lowest tank being 38 ft. above the highest line of sprinklers. These tanks can also be connected with the pipe system serving the fire hydrants. City water is used in the reservoir and tanks.

FUEL GAS.—Uncarburetted water-gas is used in the heating and baking ovens and annealing furnaces. This is furnished by two generators, each having a capacity of 25,000 cu. ft. per hour; it is stored in two tanks of 100,000 and 200,000 cu. ft. capacity. The gas is made from a good grade of furnace coke and has a heating value of approximately 300 B. T. U.; its cost (exclusive of fixed charges) is said to be such as to enable it to compete favorably with coal of 12,000 B. T. U. costing $2.80 per ton. It has about 50% less heating value than city gas, and costs about 50% less than the latter.

ELECTRICAL MACHINERY.—The power plant has four generating units with a total capacity of 3,000 KW. for continuous service or 4,500 KW. for a period of two hours. The various pipes and electric cables from the power-house to the several buildings are carried in lighted and ventilated tunnels 7 ft. high and from 4 to 10 ft. wide. All the machinery is electrically driven, and individual motors are used except in a few cases. The main machine shop and cable-making plant contain many variable-speed motors which are operated from a three-wire system. A compensator or voltage balancer in each of these buildings is of sufficient capacity to carry the unbalanced load resulting from the variable-speed motor load. The machinery includes not only the usual class of machine tools but also machines for insulating the wires, twisting the wires in pairs, and twisting these pairs into cables. There are 80 insulating machines, each of which handles five wires simultaneously. The largest cable twisting machine will carry nearly 600 spools of twisted pairs of wires and is driven by belting from a 30-HP. motor. In the department for applying the lead casing to the cables there are several 30-HP. slow-speed motors, each directly connected to the crank-shaft of a pump operating a hydraulic press used in this process. In the rubber department, there are motor-driven machines for washing, grinding and otherwise treating the crude rubber.

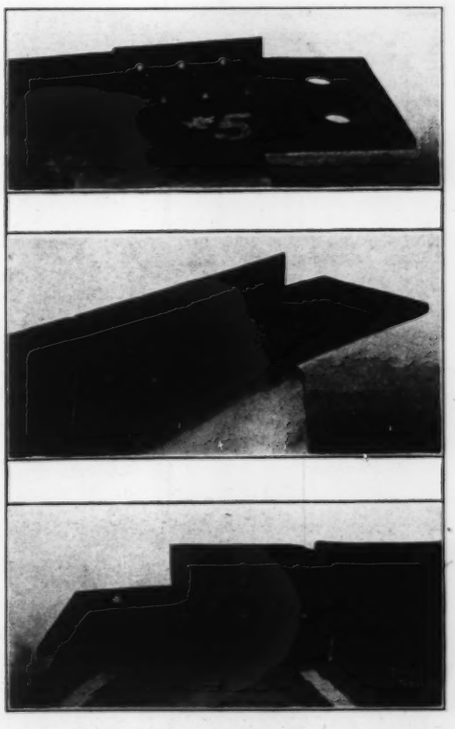

Fig. 5. Near Views of Three Typical Fractures.

REINFORCED CONCRETE BANK AND OFFICE BUILDING, LOS ANGELES, CAL.

By Max J. Welch.*

At the present time, on the Pacific coast more especially, the absorbing question among architects and engineers is the value of all-concrete building construction as compared with steel and concrete or other types of fireproofing. The engineer has to juggle his brain over theory, open his eyes to practical tests, and guess at the remainder; but of all the nerve racking problems, the greatest one now confronting the Western man is how to construct a building that will stand through an earthquake.

The Citizens National Bank Building, at the corner of Third and Main Sts., in Los Angeles, Cal., shown in the accompanying view, has just been completed. It is the first building of its kind in Los Angeles; that is, reinforced concrete throughout with the exterior finish molded in concrete. The under part of the cornice work, at the top, is monolithic concrete. This is not difficult or expensive ornamentation when we consider that it is built of forms made with standard section moldings and does not require accurate carpenter work.

The first two stories outside are faced with concrete building blocks, 5½ ins. thick, of a neat design, each block being anchored to the main concrete structure with two ⅝-in. anchor bolts grouted in place. Above this facing is a heavy concrete water table. The outside finish above the water table is bush hammered panel work; that is, after the forms had been removed, the border edges of the panels were left smooth and the interior of the panels were bush hammered to give the appearance of rough stone. The ornamental figures, extending the full height of the sixth floor, are of staff. The projecting cornice on top is of galvanized iron, painted to match the steel grey color of the concrete.

It is more to the point at present to examine into the engineering details of the construction. The entire building above the ground floor is a duplicate of columns and floor design throughout. The builders recognized that a standard of construction is cheaper than a whittling down of sizes. The ground floor was designed for 200 lbs. live load per sq. ft.; all other floors for 100 lbs. live load, with a factor of safety of three when the total dead and live load is applied. A test was made of the ground floor with a load of Portland cement in sacks. A load of 450 lbs. per sq. ft. was placed over one entire panel, inside of four columns. This test showed a deflection of 5/16-in. at the center, with no visible cracks.

*Los Angeles, Cal.

Fig. 2 is purposely drawn out of scale in order to show clearly in small space the details of the second floor. The only variation from this design, above the ground floor, is in the reduction of the size of the four bars of the columns in succeeding floors. The reinforcement used is mild commercial steel of the square twisted bar type.

Section A-A, Fig 2, shows the design of the columns. Four 1½-in. twisted bars were held in place by a special template and each 14 ins. throughout the length; these bars were lashed with ¼-in. round mild steel. The template was then removed and the steel net work column suspended into position. At each floor the projecting upper ends of the corner bars were covered with a pipe sleeve. The bottom ends of the corner column bars, for the floor above, were inserted and grouted into these sleeves.

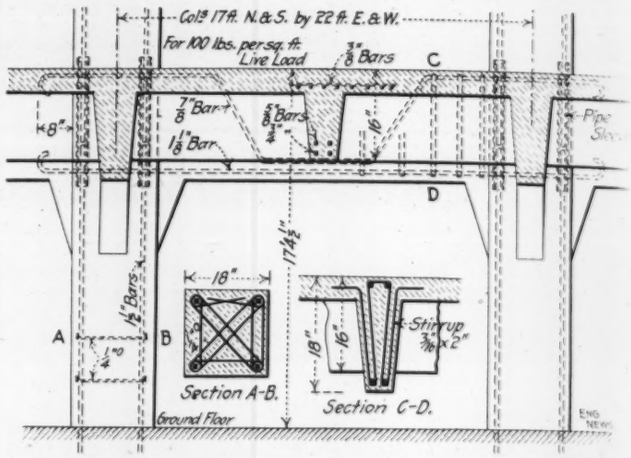

FIG. 2. SLAB AND GIRDER FLOOR AND COLUMN DETAILS, CITIZENS' NATIONAL BANK BUILDING.

The columns are connected four ways at each floor, with a girder shown in section B-B. The distance from the face of column to the point where upper reinforcing bar is bent down is kept 28 ins., regardless of the span. The next adjoining distance of 32 ins. is also maintained. The vertical stirrups to take up horizontal shear and secure the main reinforcements are of 3/16 × 2-in. steel. These are placed 18 ins. on centers everywhere except at the ends of girders where the shear is greater.

Connecting the centers of each of the large girders are smaller 16-in. beams, with lighter reinforcement but of the same general design as described above. The floor is reinforced with ⅜-in. square twisted bars, 4½ ins. on centers, laid both ways. The nature of the main girder is that of a continuous beam. The 16-in. cross beams, extending both ways, would allow various assumptions as to the actual load carried by the large girder.

The unit compression strain on the first floor columns, section A-A, is of interest, as this seems to an observer to be the weakest point in the building. The dead load on one column, near the base, for each floor, taking 140 lbs. per cu. ft. for the concrete and allowing 1,000 lbs. for the steel, is 29,840 lbs. Five floors and the roof at 48 lbs. per sq. ft. brings the total dead load up to 162,000 lbs. This is 500 lbs. per sq. in. total area of column. If all five floors were loaded further to 100 lbs. per sq. ft. (live load) the compression strain on first floor column would be 1,077 lbs. per sq. in. These columns contain 9 sq. ins. of steel distributed to the four corners and 315 sq. ins. of 1-2-3 concrete.

All the concrete was made of the best grade of Portland cement, clean river sand and crushed granite. All that crushed granite that was retained on a ¼-in. screen and passed a 1¼-in. ring was used for a general mix. That which passed the ¼-in. screen was used in the floor finish. The various mixtures was as follows: Retaining walls, 1-2-6; footings, 1-2-5; floors, 1-2-4; columns and beams, 1-2-3.

The actual strength of well-designed monolithic concrete, to resist say an earthquake shock, is hardly conceivable. For tension, the engineer must not depend on concrete to any degree because if a shrinkage crack develops in any part of the structure the whole is unsafe. However, as a mass, the tension value of concrete does exist and binds the whole structure together stronger than any other type of fireproofing. Note the comparison with hollow tile fireproofing. Each joint of the tile is an actual crack of itself, depending upon compression for firmness and adhesion of the mortar joint.

Mr. Harrison Albright was the architect and W. B. Roberts superintendent of construction for the above building. The last three stories were erected in 20 days.

FIG. 1. REINFORCED CONCRETE BUILDING FOR CITIZENS' NATIONAL BANK, LOS ANGELES, CAL.

THE COST OF PUMPING WATER at Chicago is given as 2.28 cts. per 1,000 gallons in a report recently made to the Commissioner of Public Works by Mr. John Ericson, City Engineer. The cost is further classified as follows: For water that produces revenue, 6.14 cts. per 1,000 gallons pumped; for water that produces revenue and water furnished free, 5.43 cts.; for all water pumped, 2.28 cts. As to the distribution, it appears that 15% is metered water paid for, 22% is unmetered water paid for, 5% is furnished free (including that for the city's use and for fire purposes); this leaves 58% of the total amount pumped classed as "unaccounted for." The cost of pumping is said to be a very fair average, but varies slightly from year to year, depending on the price of coal, etc. The cost as given includes that of special sewerage works for the reason that they are for the protection of the purity of the water supply.

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The use of tar and heavy oils for dressing the top surface of a macadam road appears to be growing in favor. Of the two materials, tar appears to give the best results, as would naturally be expected. Success in the use of either material, however, appears to depend on the work being done right from start to finish. It is essential that the road be dry, and that no water reach it, from rain or other source, until the tar or oil is thoroughly incorporated with the fine material on the road surface. Further, a coat of sand, crusher dust or other fine material must follow the application of the tar and must be left on until the tar is thoroughly absorbed, or the nastiness of the road surface will bring down public condemnation on the head of the official responsible for the application.

It is no argument against the use of tar, however, that the work must be properly done to be successful. Every other engineering material is subject to the same restriction. Accounts agree that with tar or heavy oil properly applied, the dust nuisance is greatly lessened, the wear of the road is reduced, the surface is waterproofed so that the whole roadway is protected from the action of rain and frost, and in general an admirable road surface is secured at a moderate cost.

The storage of coal under water to protect it from the deteriorating effects to which it is subjected by long exposure to the air, has been suggested several times and some extensive experiments have been made. No adoption of this system on a commercial scale has so far been made, we believe, but in an article on another page describing the plant of the Western Electric Co., mention is made of the fact that this company is building two storage tanks of 4,000 and 1,000 tons capacity in which the reserve supply of coal will be stored under water. The principal purpose is to protect the coal from deterioration, but it also has the advantage of preventing the possibility of spontaneous combustion or accidental ignition of the coal, which are serious elements of danger in coal stored in large quantities. The system of storing coal under water has so far been advocated mainly for storing at naval stations, and the British Admiralty has had a series of experiments in progress at Portsmouth for three years. In May, 1903, the engineers selected 21 tons of coal from the storage piles; ten tons were stacked in heaps and covered with tarpaulins; ten tons were placed in five 2-ton crates and submerged in one of the navy yard basins; the other ton of coal was burned and careful observations were made as to its calorific and evaporative qualities. At intervals the crates have been taken up and the coal tested by burning in comparison with coal stored on dry land for the same length of time. It is reported that in every case the results have been in favor of the submerged coal. In a paper in "The Engineer" of London, Oct. 30, 1903, this subject was discussed by Mr. J. Macaulay, General Manager of the Alexandria Docks & Railway (Wales), and it was stated that the deterioration of coal by exposure to the atmosphere is both chemical and physical. Some of the contained gases are given off, especially in climates of high temperature, and the oxygen of the air enters into combination with what remains in the coal to form other and less inflammable gases. The physical deterioration is due to the combined action of sun, rain, wind and frost, so that in the handling of coal which had been stored for several months the loss by waste and breakage would be much greater than in the handling of fresh coal. When stored under water it remains in a practically uniform condition, and its superiority over air-stored coal is due to the fact that it is able to retain its physical character and also to retain its volatile and non-volatile constituents. It has been claimed that impregnation by the salt of sea water has some effect in improving the quality of the submerged coal, but this is problematical. At the Western Electric Co.'s plant, of course, fresh water will be used. The experiment at this plant is a notable one, and its results will be watched with interest.

The subject is one of particular interest to the British navy department, as its coaling stations are scattered all over the world, many of them in climates which are especially severe upon air-stored coal. Ships which coal at these stations may be expected to show a reduction in their speed and steaming capacity. As the ability of warships to develop their full power may be of the utmost importance, and as this depends to a great extent upon the quality of the fuel, the possibility of maintaining coal in better condition by storing it under water is a matter well worth very serious consideration. At the same time, the matter is also of importance at all places where coal is stored in large quantities and for considerable lengths of time, either for shipping, railway, power or general commercial purposes. As a practical demonstration of the quality of submerged coal, Mr. Macaulay had tests made with coal recovered from the dock and the river, which had been lost overboard or drifted from wrecks of colliers. Some of this was known to have been under water for ten years, and some for three years. The coal was used in the locomotives in competition with the best Welsh steam coal. It was dried by 36 hours exposure on the coaling platform, but it is pointed out that on ships the coal is often stored in wet bunkers and its damp condition is rarely made an objection. In point of efficiency, the coal which had been submerged for ten years showed the highest results; the fresh mine coal came second, but was only 1.6% better than that which had been submerged for three years. Mr. Macaulay did not believe that submergence had actually improved the quality, but considered that its superiority was largely due to the loss of the softer and less valuable outer portions of the lumps. The conclusions arrived at may be summarized as follows: 1, coal stored in the open air for any length of time generally loses about 10% of its steam raising power, most of this loss occurring during the first twelve months; 2, steam coal loses very little of its efficiency by submergence under water, and this method of storage appears to offer economic and other advantages over storage with exposure to air (whether in the open or under sheds); 3, the saving of calorific value and working power is probably due to the more complete retention by the coal of its original chemical and physical properties, which are liable to be lost during exposure to the air by oxidization, the dissipation of natural volatile constituents, and the weathering due to climatic and atmospheric influences; 4, there may possibly be some increase in the working power of coal submerged in sea water due to its being permeated by the salt from the water.

MUNICIPAL OWNERSHIP: THREE IMPORTANT CHANGES IN THE PUBLIC POINT OF VIEW.*

The question whether cities ought to own and operate what for convenience are often called public utilities, is not a new question. In one form or another it has been before the public for the past half century, and even longer.

During the past twenty years, however, these public utilities, which once were only conveniences, have become necessities and have attained a vastness of proportion undreamed of two decades ago. It is this fact that has brought the question of public ownership to the front and has made it a far more vital and important question than it was thirty or twenty or even ten years ago. The horse cars and gas lights which were the public utilities of a previous generation might be used or let alone; they were not a necessity to the public; but to-day in all cities of any size, the street transportation and the lighting systems are as much necessities, under modern living conditions, as food and clothing itself. It is this that makes the question of municipal ownership of immediate practical interest to the public at the present day.

It is often said, nowadays, that the voters, or at least the majority of them, have made up their minds already regarding municipal ownership, and that whenever and wherever the issue is fairly presented to them, the vote will be recorded in its favor. While this is indeed an important change in the public point of view, we wish to call attention to changes of a different sort—to the change in position of the enemies as well as the friends of municipal ownership.

The first of these changes may be defined as the general recognition of the importance of franchises and franchise restrictions.

Twenty to forty years ago, if any one wanted to use the streets of a moderate sized city or town for laying water or gas pipes or railway tracks, the securing of the permit for such work was commonly regarded—alike by the public and the promoters—as a mere legal form. There were even those who went so far in their devotion to individualism as to advocate the removal of all restrictions upon the use of the public streets.

Promoters roamed all over the West and South, securing franchises for all sorts of public works, and there was seldom any question of restrictions or compensation in granting them. It was not a question of, How much will you give the city for the franchise? or, How cheaply will you furnish the citizens water or gas? but, How soon will you agree to have the works completed and in operation? The first attempts to introduce restrictions into franchises and to exact payments from franchise holders were fought tooth and nail on the ground that the development of the city would suffer if capital were frightened away by such demands.

Those days, however, are long since past. The opponents of municipal ownership freely admit now that franchises for public utilities are valuable, and that the companies holding them ought to pay for these valuable rights, either directly to the public treasury or indirectly in the way of low fares or rates. They admit also that every franchise should have proper restrictions to safeguard the public against loss and—most important of all—they admit that, since no one can foresee the future, every franchise ought to be of limited duration. Nobody raises his voice any more in favor of perpetual franchises, well knowing that to do so would merely render him absurd.

The second point in which a great change has

*The substance of this editorial was presented as an address by Charles Whiting Baker, Managing Editor of Engineering News, in opening the discussion on Municipal Ownership, at Ithaca, N. Y., July 2, at the joint meeting of the American Economic Association and the American Association for the Advancement of Science.

taken place in the public point of view is the recognition of the fact that municipal public utilities are and ought to be monopolies; that competition in the street railway service, the gas or electric light supply, the water supply or the telephone system of a city is a monstrous absurdity and an economic waste.

It is still possible, of course, to find sporadic cases where attempts at competition are offered; but they are few and far between compared with twenty years ago. Capital has learned to be wary of such competitive schemes, and the public—or at least the more intelligent portion of it—has learned that no permanent benefit, but rather permanent injury, results from attempted competition in this field. Thus, while old errors die hard and fossils may still be found which retain the imprint of the *laissez faire* doctrines that were popular a half century and more ago, the great body of the public has settled down to accept monopoly as a practical existing fact of modern city life. The man in the street—as our English cousins say—looks to the legislature and not to competition to reduce the price of gas; and even if a promoter appears in a city with offers to furnish far better or cheaper service than an existing company, the public has no faith in his promises.

It is important to note, too, that the opponents of municipal ownership accept with the rest of us the fact of monopoly. They no longer expatiate, as they did twenty years ago, on the beauties of free competition as a panacea for all ills, and on the evils of any interference of the state or city government with private industry. On the contrary, they freely admit that monopoly in municipal public service is best for the companies as well as best for the public, and also admit (because they have to) that such monopolies must of necessity be amenable to regulation and control by public authority.

It is certainly a great step in advance, in the discussion of municipal ownership, to have the issue squarely and fairly presented. The public need no longer be confused by the old-time argument that the city should have nothing to do with the street railway business or the gas business or the electric lighting business. In any city that makes the slightest pretence to decent and honest government, the city authorities *must* control the use of the public streets, and must see to it that any company which uses the streets to supply the residents with gas, electric current, telephone communication or passenger transportation, shall furnish good service and charge no higher rates therefor than are necessary to earn a fair rate of interest on the invested capital.

The municipal ownership discussion, therefore, narrows down to the question whether the public utilities shall be owned and operated by the city or by private companies working under permit from the city government, furnishing such service as the public authorities may require, and at rates subject to government control.

But when we view the question from this standpoint it is seen at once to be a question of policy and not one of principle. The old argument that municipal ownership was to be abhorred because it was a step toward socialism can no longer be used. The inexorable logic of events has forced city governments the world over to concern themselves with street railways and gas and water supply and sewerage, and there is no getting away from the task.

Taking up now the issue thus squarely defined, it is probable that the strongest argument that is ever brought against municipal ownership and operation is the argument that municipal management is very apt to be inefficient, dishonest, and, consequently, expensive. Candid advocates of municipal ownership have had to admit, to a greater or less extent, the truth of this indictment, and have had no thoroughly effective reply with which to meet it.

The events of the past year, however, it is not too much to say, have radically changed the situation. The public has learned that there are other inefficiently managed industries besides those owned and operated by the government; that there are grafters in private business as well as in public business, and that in the last analysis the voters in a municipal corporation may have as much voice in its conduct, and as much ability to secure efficient and honest management as have the stockholders of a gas company or the policyholders in a life insurance company.

It may be said, of course, that this is nothing new; that what may be called the seamy side of corporate management has been more or less known by those conversant with large financial and business affairs for a long time. Nevertheless the fact remains that the people as a whole have not known. The things which the muckrake has uncovered during the past twelve months have been revelations to the general public.

The third important change in the public point of view, then, is a realization of the faults and failings that occur in private business management; and a consequent fairer view of the municipal ownership question.

As has just been stated, it is merely a question of policy, whether the city shall control its public utilities while permitting private corporations to own and operate them, or whether it shall do the whole work itself. Which is the wiser policy will depend on the relative efficiency of the two agencies. The public is familiar with corruption in municipal administration; and it has now learned that corruption of a very similar sort is more or less prevalent in private business enterprises, particularly those carried on by large corporations.

In this connection it is worth while noting that the opponents of municipal ownership have in their past arguments been wont to compare, not city management with corporation management, but city management with private individual management. This is an error which deserves correction. There are, of course, still a few cases in small cities where an isolated water or gas works or street railway line is managed by a private owner; but these instances are far from typical. In nearly all cases municipal franchises are held by large corporations, in whose business something of the same inefficiency and red tape are to be found that are popularly supposed to belong only to government business. For illustration, it is a common complaint in city administration that the different departments do not properly cooperate with each other—the health department with the water department, the sewer department with the street department, etc. Exactly this same complaint is heard at times from private corporations. Again, the value of a "pull" to the city employee is well known—and since the enactment of civil service laws is often overestimated. Our own readers can testify whether "pulls" are of any importance in securing and holding good places in private corporations. Highly paid sinecures are not confined to city offices. The ability and willingness to cooperate in keeping secret the acts of men "higher up" is an important matter in some private corporations as well as in the municipal service.

Let it not be understood that we intend by these remarks any wholesale indictment of present day business conditions. We believe, on the contrary, that the great majority of men, in the service of private corporations and of municipal corporations as well, are honest.

We are not arguing, either, that there is *no* difference between public and private management. The probabilities are strong that the public utilities operated by private companies are on the whole more efficiently managed than those under municipal administration. What we do maintain is that the contrast between the two is far from being as great as is usually claimed.

If the foregoing analysis is correct, then question of municipal ownership is one settled each case by itself on its own mer as, in fact, it has been settled in the past. city may find it the best policy to own and its own water supply or electric lighting syst whereas another city under different condit may obtain better results by contract with a vate company. It is for this sane and so view of the municipal ownership question we stand.

LETTERS TO THE EDITOR.

A Condensed Earthwork Table.

Sir: Earthwork or yardage tables now used in r road construction are generally based upon the mean area method of computation, and the formula

$$S = \frac{L}{2 \times 27} (A + A')$$

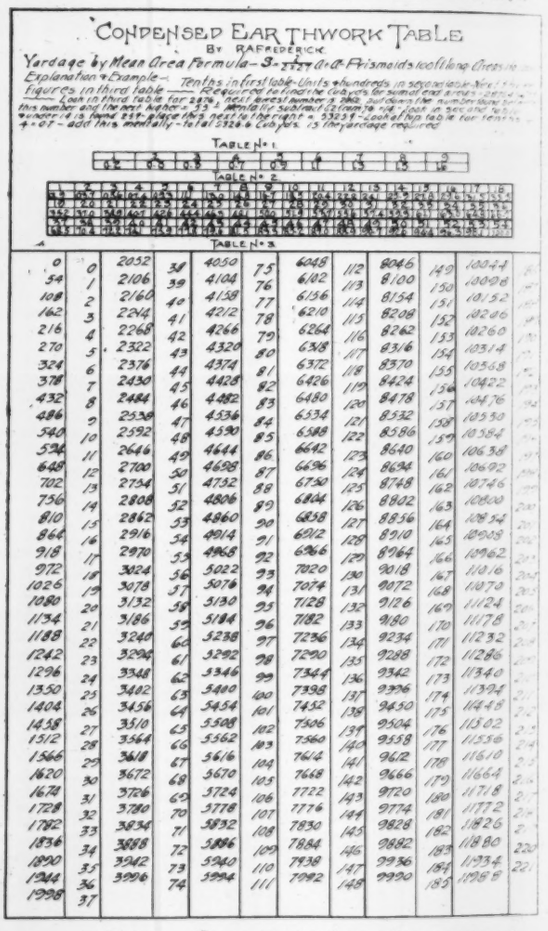
has been approved by statute for all public works in New York in which:

S = cu. yds.

L = length of prismoid = 100 ft.

A and A' = areas of the two ends of the prismoid.

Such tables are now published in several forms, the most common being to have the tenths taken out of a supplementary table at the top of the sheet, the whole numbers being arranged so as to take areas up to 500 from a single sheet by reading the table "both ways."


CONDENSED EARTHWORK TABLE

BY RAP FREDERICK

Yardage by Mean Area Formula—$S = \frac{L}{2 \times 27}(A + A')$ Prismoids 100 ft long

Explanation + Example—

Figures in third table—Tenths in first table—Units + hundreds in separate table

—Look in third table for 2276, next largest number is 2268, but down the number

the number and the next higher is 23 + add to it subtract 2 from the 1st figure in next line

4-07 - add this mentally - total 2326 6 Cub. yds. is the yardage required

TABLE No. 1

TABLE No. 2

TABLE No. 3

0	0	2052	38	4050	75	6048	112	8046	149	10044	
54	1	2106	39	4104	76	6102	113	8100	150	10098	
108	2	2160	40	4158	77	6156	114	8154	151	10152	
162	3	2214	41	4212	78	6210	115	8208	152	10206	
216	4	2268	42	4266	79	6264	116	8262	153	10260	
270	5	2322	43	4320	80	6318	117	8316	154	10314	
324	6	2376	44	4374	81	6372	118	8370	155	10368	
378	7	2430	45	4428	82	6426	119	8424	156	10422	
432	8	2484	46	4482	83	6480	120	8478	157	10476	
486	9	2538	47	4536	84	6534	121	8532	158	10530	
540	10	2592	48	4590	85	6588	122	8586	159	10584	
594	11	2646	49	4644	86	6642	123	8640	160	10638	
648	12	2700	50	4698	87	6696	124	8694	161	10692	
702	13	2754	51	4752	88	6750	125	8748	162	10746	
756	14	2808	52	4806	89	6804	126	8802	163	10800	
810	15	2862	53	4860	90	6858	127	8856	164	10854	
864	16	2916	54	4914	91	6912	128	8910	165	10908	
918	17	2970	55	4968	92	6966	129	8964	166	10962	
972	18	3024	56	5022	93	7020	130	9018	167	11016	
1026	19	3078	57	5076	94	7074	131	9072	168	11070	
1080	20	3132	58	5130	95	7128	132	9126	169	11124	
1134	21	3186	59	5184	96	7182	133	9180	170	11178	
1188	22	3240	60	5238	97	7236	134	9234	171	11232	
1242	23	3294	61	5292	98	7290	135	9288	172	11286	
1296	24	3348	62	5346	99	7344	136	9342	173	11340	
1350	25	3402	63	5400	100	7398	137	9396	174	11394	
1404	26	3456	64	5454	101	7452	138	9450	175	11448	
1458	27	3510	65	5508	102	7506	139	9504	176	11502	
1512	28	3564	66	5562	103	7560	140	9558	177	11556	
1566	29	3618	67	5616	104	7614	141	9612	178	11610	
1620	30	3672	68	5670	105	7668	142	9666	179	11664	
1674	31	3726	69	5724	106	7722	143	9720	180	11718	
1728	32	3780	70	5778	107	7776	144	9774	181	11772	
1782	33	3834	71	5832	108	7830	145	9828	182	11826	
1836	34	3888	72	5886	109	7884	146	9882	183	11880	
1890	35	3942	73	5940	110	7938	147	9936	184	11934	
1944	36	3996	74	5994	111	7992	148	9990	185	11988	
1998	37										

The accompanying table is one which I have originated and it possesses some very interesting features. I call it a "Condensed Earthwork Table." With a trifling mental subtraction and addition, any quantity for sum of end areas up to 12,000 sq. ft. can be taken from a single sheet the size of a leaf in "Searles' Field Book" when printed. This table can be inserted in any field book with a leaf the size of the "Searles'" or can be pasted on a piece of cardboard and carried in the pocket, making it unnecessary to turn over several leaves of the ordinary earthwork yardage table when taking out quantities which I need not explain here. Recently a new form for such a table has appeared by Mr. R. S. Henderson which has the advantage over the old form of showing a little over 1,000 sq. ft. area quantities on a single sheet or page by an arrangement which is quite ingenious.

An explanation and example is printed on the same sheet and one edge is gummed for insertion in the field book. The table is copyrighted and will be for sale shortly.

Yours truly, R. A. Frederick,
Resident Engineer, Grand Trunk Pac. Ry.

Fort William, Ont., April 10, 1906.

Concerning the Right of an Engineer to Have the Best Offer for His Services."

Sir: Noting a communication from "R" and your reply thereto upon the above subject in your issue of June 21, I desire to add the following as coming under my own observation:

Some years ago while the writer, as next in charge, was connected with the engineering department of a large terminal property in the West, a change of officials at the head of the engineering department took place at the commencement of some very important reconstruction work. Soon after the arrival of the "new official," several of the assistant engineers received very good offers from other railroads which were accepted, since the "new official" was endeavoring to hold down salaries and these men had no prospect of getting any further increase where they were. The "new official" endeavored, through me and others, to find out where the assistant engineers had gone and at the same time he informed me, in the presence of others, that he was going to stop his men from leaving if he could find out which companies were offering the men better salaries. Later he informed me that he had made arrangements with the other railroads in that city, not to take away any more of his men. The force eventually heard that the "new official" had taken measures to prevent their being employed by other railroads centering in that city.

On one occasion an assistant engineer in charge of the reconstruction of steel work of a bridge approach was engaged in laying out lines underneath the structure when a workman above, in the employ of the "erecting contractor," carelessly dropped a large plate down upon the engineer's right hand without warning, breaking several bones. The "new official" endeavored to force the engineer to sign a paper relieving the "erecting contractor" from any action for damages on account of the injury, and the "new official" threatened the engineer with the loss of his position if he did not sign the release. He only ceased his endeavors when informed by the railroad company's legal department that he, the "new official" was following the wrong course in threatening to discharge the engineer. The final result was that the "new official" was asked to resign his position as head of the engineering department. Four months after, the writer left the company's service for his present position.

In view of my own experience I feel that what "R" has written is only too true, but whether these are isolated cases of "unfairness to employees" or common practice, I am unable to say.

I am particularly pleased to note the sentiment expressed in your lines following "R's" letter, and it is to be hoped that your remarks will be read by Chief Engineers of railroads.

Yours truly,
M.

New York, June 22, 1906.

Passing a Tangent from a Curve Through a Given Point.

Sir: During the past six months or so there have appeared from time to time in Engineering News, problems in railway location of more or less general interest. One problem in particular attracted my attention, not so much on account of its importance as the difference in the methods of solution. The problem I refer to is the passing of a tangent from a curve through a given point. This is a very simple problem and frequently met with in practice, and yet in all of my practice of upwards of 25 years, I have never found an instance where it was necessary for the tangent to pass precisely through the given point. I have always used the method given in nearly all Field Books and recently given in detail by "G," in Engineering News of March 15, 1906.

If a rigid method is necessary, the following method seems to be the most natural and at the same time to a certain extent general in its application.

CASE I.

Given: a curve and a distant point to find a tangent that shall pass through the point.

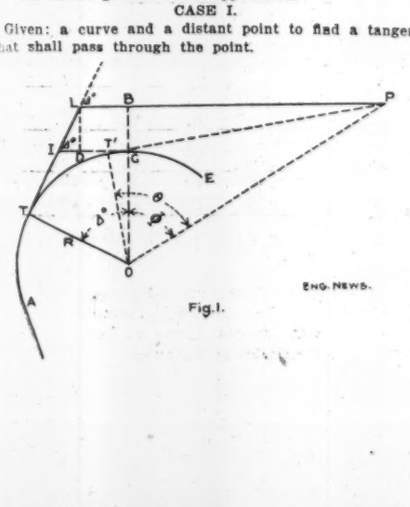


Fig. 1.

Let A C E (Fig. 1) be the given curve and P the given point, to find the line T' P tangent to the given curve through the point P. At some point T on the curve turn tangent to the curve and measure the distance to some point L. At L measure the angle Δ° through the point P and also the distance L P. With Δ° as the intersection angle calculate the semi-tangent T I = I C, T L − T I = I L. Calculate L D = B C also I D, I C − I D = D C = L B.

B C + C O = B O and L P − L B = B P, $\frac{B P}{B O} = \tan \phi$.

$$O P = \sqrt{(B O)^2 + (B P)^2}$$

$$O T' = R \frac{O T'}{O P} = \cos \theta$$

The difference between θ and ϕ deducted from Δ° is the angle through which the curve must be run to reach T', the point of tangency of the line T' P through P, T' P' = O T' tan θ.

CASE II.

Given: two curves exterior to each other to find the tangent points of a line tangent to both and its length between tangent points.

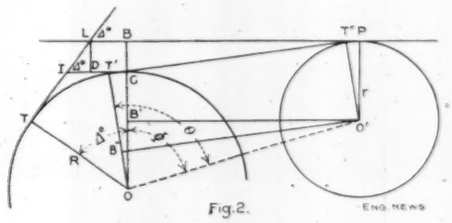


Fig. 2.

Let O and O', in Fig. 2, be the centers of the given curves, R and r their radii respectively and T' and T'' the required tangent points.

At some point T on one of the curves, turn tangent to the curve and measure the distance to the point L which is on a line tangent to the other curve at P. Measure the angle Δ° and also the distance from L to P.

With Δ° as the angle of intersection of two tangents, calculate in the usual way the tangent distance T I = I C, T L − T I = I L;

Calculate L D = B C also I D, I C − I D = D C = L B;

B C + R = B O and L P − L B = B P.

B O − r = B' O and B' O' = B P.

$$\frac{B' O'}{B' O} = \tan \phi, \quad O O' = \sqrt{(B' O)^2 + (B' O')^2}$$

$$R - r = B'' O \frac{B'' O}{O O'} = \cos \theta, \quad B'' O' = O O' \tan \phi,$$

$$B'' O' = T' T''.$$

The difference between θ and ϕ deducted from Δ° is the angle through which the curve must be run to reach T' the point of tangency of the line T' T'' tangent to both curves. It is evident that the angle T'' O' P = $\theta - \phi$.

CASE III.

In this case the curves are reverse to each other as in Fig. 3, but the process is exactly the same as in Case II. only we must substitute + r for − r.

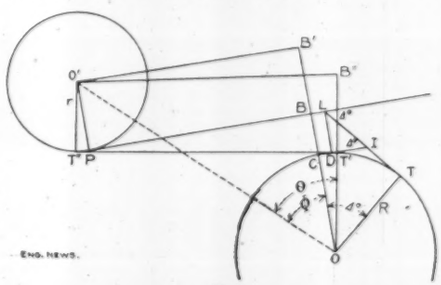


Fig. 3.

It will be seen that the one solution is applicable to all three cases: In Case I., r = O, in Case II., r is minus, and in Case III., r is plus. To this extent the solution is general and the process is along well beaten paths and the work is the simplest kind of trigonometrical calculation, there being no triangles to solve except right-angled triangles. The field work is reduced to a minimum as there is only one set-up of the transit off the curves.

By this method the problem given by Mr. W. W. Urquhart in the Engineering News of Oct. 26, 1905, can be calculated in one-quarter of the time, provided a line can be run without much trouble approximately in the direction S — T on Mr. Urquhart's sketch. All indirect methods of field work are bound to be unsatisfactory although the theory may be perfect.

Very truly yours, W. H. Sadler, C. E.,
Asst. Engineer, D. & H. Co.

Plattsburgh, N. Y., May 10, 1906.

The Design of Reinforced Concrete Beams and Slabs.

Sir: The writer asks for the privilege of presenting a reply to Mr. E. Godfrey's letter in your issue of May 3, not for the sake of continuing a discussion and sparring for the last word, but because many points are raised of an exceedingly practical character, on which the writer earnestly seeks for light. If Mr. Godfrey's statement that 1¼% is the proper amount of steel reinforcement is correct, then the writer is wrong by over 100% and naturally feels great uneasiness over the safety of numerous structures which he has designed, and which have been built on his theory. His only justification must be, that he has erred, not through carelessness, but through unavoidable ignorance which is shared by a great number of his colleagues. He would like to ask Mr. Godfrey and beyond him, all practical designers who may notice this letter, whether they have used a percentage of 1¼ or one nearer 0.60 in their actual work. If they have used the former, they were more fortunate than the writer in not having had to meet close commercial competition.

A great number of times estimates made on the writer's theory have been beaten by reputable rivals and those of his designs which were executed did not differ by any material amount from other plans. The sizes given by his theory have usually compared closely with those by other more competent designers and, moreover, have passed the careful scrutiny of building inspectors. If he is radically wrong, he can only regret that he did not follow the advice of one of the best known bridge engineers given some years ago who told him that he was too young to risk his reputation by dabbling with reinforced concrete, because in the course of time such structures would develop numerous flaws as yet hidden from observation. As a matter of fact, a concrete engineer has to take too many chances from poor materials and lack of care in execution of his work to add deliberately another grave risk of error from theory. Where so much uncertainty exists, he must accept the best current practice, select the most reasonable theory as a basis for his designs and await the consequences, assured that he cannot be held morally responsible for defects which could not be prevented by using all due precaution. The case would be different with a designer who uses gross section instead of net of the steel reinforcement with the intention of making his customer believe he was getting more than he actually received. This is a matter in which ignorance cannot be excused.

Mr. Godfrey takes up considerable space in combating statements never made by the writer, which cover points on which, as a matter of fact, they are in agreement, as will be shown. He also talks about "mathematical dust" and "bald" statements. The "mathematical locomotive" naturally raises a great deal of dust in its flight through space like its material prototype, but that is a by-product which need not concern the man at the throttle. It can be left to be gathered up by the poor professional mathematicians, for whom most engineers profess such a marked contempt. As to baldness, the writer does not worry about being in that incipient condition himself, but feels very much concerned about his statements having reached that stage.

To bring matters to a definite issue the writer will briefly state the fundamental assumptions of Mr. Christoph's theory and ask Mr. Godfrey's and others' opinion, why in the present state of the art they are not the best, avoiding unnecessary refinement on the one hand, and being sufficient on the other to serve as a broad basis for elaboration. If they are correct, the writer feels no hesitation in following wherever they lead to. These assumptions are five in number: (1) Solidarity of concrete and reinforcement, provided the latter is so arranged as to assure a sufficient bond between the two; (2) invariability of plane sections; (3) invariability of the coefficient of elasticity of concrete in compression within the usual limits of stress; (4) neglecting the action of concrete in tension; (5) absence of initial stresses.

Mr. Godfrey speaks in all cases of ultimate values, whereas the ordinary theory does not pretend to follow beyond the elastic limit, either in steel or in concrete steel, and it therefore seems that results deduced from testing beams to failure have little value as interpreted by our ordinary formulas. Moreover, beams of rectangular section, which are the only ones fully discussed in textbooks and experimented on, are very little used in actual practice as compared with beams of T section where the floor slab is counted on for part of the compression flange. What percentage of steel would Mr. Godfrey fix on for that case?

As to the writer's definition of "depths of beam" it is the only rational one to use, even if this statement is bald. Take a shallow beam, say 8 ins. deep and a deep one, say 36 ins., both within practical everyday limits. In the one case Mr. Godfrey would get 1 in. and in the other 4½ ins. for the amount of concrete under steel. Would he actually use these figures in a commercial design? This amount will rather be found to be a constant and that because of a very important consideration which Mr. Godfrey has not touched on. That is the protection afforded against fire, and here a great diversity of opinion exists. Prof. Chas. L. Norton, as quoted in Taylor & Thompson's book on concrete, considers 2 ins. in all

beams and girders essential and most building regulations call for at least that amount. However, no more than 1½ ins. has been used very often and passed by some building departments. In a fire test of a system which has never used more than that amount it was increased to 2¼ ins. for the purpose of the test only, according to the writer's best knowledge and belief. There is also another point in this connection which has not been commented on, and which deserves careful consideration. In order to attach shafting or pipes to reinforced concrete beams, many different devices have been used, among others some in which a socket or similar device is in close contact with the reinforcement. In case of fire, heat is thus transmitted directly to the steel reinforcement with the result of heating it rapidly and causing the concrete protection to fall off, due to the unequal expansion, the concrete taking a much longer time to heat to the same temperature than the steel; therefore, such devices should not be allowed, or, if they are, the buildings so constructed should not be held up as examples of fireproof construction. The last two points mentioned have apparently been frequently overlooked but should not be slighted in the future.

If the inventor of a system is compelled to use features which cannot comply with scientific requirements and tries to pass them off under the sanction of the building department of a prominent city, he is no better than the packer of poisoned meat who uses the apparent sanction of United States government inspection which, when closely investigated, has no substantial meaning, but of which fact the public knows nothing.

As stated before, there are enough unavoidable uncertainties in the subject without adding other difficulties of our own making. In the rebuilding of San Francisco reinforced concrete will play an important part, but grave fear must be entertained that unscrupulous competition will result in much reckless and "skinned" work, unless held in check by regulations and inspection which are more than a mere name.

Yours truly,

Henry Szlapka, Res. Engr. Toledo Massillon Bridge Co.
342 Mint Arcade, Phila., May 7, 1906.

RESULTS OF PLAIN AND REINFORCED CONCRETE COLUMN TESTS AT WATERTOWN ARSENAL.*

By James E. Howard.†

Tests on cements, mortars and concretes, which have been in progress during the past six years at the Watertown Arsenal, have reached the subject of columns. Of these, 99 have been tested, others have been made and await being tested, while still others of the series are yet to be made.

The tests embrace columns of different mixtures, ranging from neat cement to very lean concretes, both plain and reinforced, with longitudinal bars imbedded therein, or by the several current methods of external lateral reinforcement, consisting of hoops and other means, and also by the combined action of hoops and longitudinal bars. Reinforcing material has been received from the Expanded Metal Companies, the Hennebique Construction Co., the Trussed Concrete Steel Co., the Cummings Structural Concrete Co. and the Clinton Wire Cloth Co.

In general the dimensions of the columns are 8 ft. in height and from 10 ins. to 12 ins. in diameter. They are made in molds, excepting a number of those having expanded metal cages, which were covered with finer mesh lathing, in a vertical position, of wet mixtures, and harden in the air. They are tested in a horizontal position. For purposes of transportation, adjustment in the testing machine, and to secure even bearing surfaces, they are built upon iron plates and capped with the same. Side rods with turnbuckles are used to put the columns under sufficient initial compression to permit of being handled.

During testing, the columns are loaded with increments of 50 lbs. per sq. in., measuring the amount of compression under each increment, returning to the initial load and observing the sets. Micrometer observations are thus made on a gaged length of 50 ins., equidistant from the ends of the columns. Full details of these tests are published in Tests of Metals, a Congressional document, issued by the Ordnance Department, U. S. Army.

Table I gives the principal features of tests which have been made since the last published report, of 1905. These results, in detail, will appear later in Tests of Metals, 1906.

In presenting tests reaching up to the time of this meeting, necessarily little opportunity has been available for comparisons and deductions. Indeed, since the series is by no means completed, extended deductions should be held in abeyance. Certain features of interest, however, have been developed and will be referred to, for the illustration of which a number of diagrams have been prepared.

On diagram 1 are represented the compressive strengths of some mortar columns, plain and reinforced with longitudinal bars of ¾-in. twisted steel. The progressive loss in strength of the plain columns, as the mixtures become leaner, will be noted. The ultimate strength of the 1:1 column was not reached. It exceeded the capacity of the testing machine. This mixture was not reinforced. Each of the others was reinforced, four with 8 bars each, and one with 13. The percentage of reinforcement was about 2.86 and 4.63, the darker shaded lower ends of the figures representing the relative amounts.

The steel reinforcing bars extended from end to end of the columns, and came to a full bearing against the compression platforms of the testing machine. They were used without other lateral support than that which was afforded by the mortar in which they were imbedded. These reinforced columns would be classified as strong columns, according to current practice.

Diagram 2 shows the strength of a rich and a lean mortar, each of which was reinforced with hoops and longitudinal angle bars; also, corresponding concretes, reinforced. The hoops measured 1.5 by 0.12 in. in cross section, lapped and riveted joints. The plain 1:1 mortar displayed a compressive strength of 4,320 lbs. per sq. in., which in the hooped column rose to 5,980 lbs. The addition of two parts trap rock to this mortar resulted in a strength of 5,433 lbs. This loss in strength, by the addition of stone to a mortar, is not peculiar to this example. It has occurred in a number of cases.

The weaker 1:4 mortar was raised by the hooping and angles from 1,050 lbs. to 2,766 lbs., which in the corresponding concrete reached an ultimate strength of 3,002 lbs. The free span between the hoops, 2½ ins., permitted this lean mortar to flake off, while the larger pieces of stone in the concrete were retained in place.

On the diagram 3, which next follows, the several columns were of the same composition, namely, 1:2:4 mixtures. This diagram is intended to illustrate the effect of hooping alone, and with the further reinforcement of longitudinal angle bars. The compressive strengths of this group are as follows:

Plain column	1,413 lbs. per sq. in.
13 hoops	2,232 "
13 hoops and 4 angle bars	3,029 "
25 hoops	3,428 "
25 hoops and 4 angle bars	4,189 "
47 hoops	5,280 "

Thus it appears that the hoops and angles each contributed toward increasing the ultimate strength of the columns.

The question of ultimate strength only is now referred to, considering the gain effected by means of lateral reinforcement. It will be shown presently that rigidity of shape does not advance in corresponding degree with the gain in compressive strength. This is regarded as an important feature, not to be overlooked in judging of the advantages of exterior lateral support as compared with longitudinal reinforcement, or the gain in both strength and rigidity which accompanies the use of rich cement mixtures. Any desired strength may be attained by means of lateral reinforcement, if sufficient metal is used, but it is obvious that a certain amount of longitudinal compression of the concrete will be necessary before the lateral reinforcement becomes effective, which, in the case of lean mixtures, involves a large direct compressive movement of the column.

On diagram 4 are represented several columns which are strong by reason of their composition or on account of their reinforcement. In composition, reinforcement and strength, they are described as follows:

1:1 mortar, plain	above 5,011 lbs. per sq. in.
1:1:2 concrete, plain	3,900 "
1:2 mortar, 8¾ ins. twisted steel bars	4,200 "
1:5 mortar, 13¾ ins. twisted steel bars	3,905 "
1:2:4 concrete, 25 hoops and 4 angle bars	4,189 "
1:3:6 concrete, 25 hoops and 4 angle bars	3,862 "
1:4:8 concrete, 25 hoops and 4 angle bars	3,002 "

The relative rigidity of these columns, a feature not suggested by a comparison of their compressive strengths, is indicated on diagram 5.

The order in which the compression curves appear is the same as the figures on diagram 4, excepting the 1:1 mortar and the 1:1:2 concrete change places, the latter appearing first on the left of this group. As may be noted, the plain columns display the greatest rigidity of the several types here represented. This has been a noticeable feature in the tests as a whole.

It is even found that plain columns are a little more rigid, over the range of stresses here plotted, than the same mixtures in which longitudinal bars are used as the means of reinforcement. In so many cases has this occurred that some explanation should be sought why the presence of the steel bars, themselves so much more rigid than the concrete, should not result in increased rigidity of the column as a whole. It is not improbable that the settlement in height of the column is so far restricted by the steel bars that minute fissures are developed during the early stages of hardening of the concrete. Internal strains, without the presence of fissures, would hardly account for this behavior. The difference between the plain and the longitudinally reinforced columns is not great, however, in this respect.

The hooped columns are a distinct group, and decidedly more compressible than the others. Comparisons are now being made between columns of different mixtures, and, it may be added, the leanest mixtures are expected to display the greatest compressibility. However, lateral reinforcement, while effective in raising the ultimate strength for loads once applied, does not result in imparting rigidity to a weak concrete. The value of lateral reinforcement, as a method of raising the limit of endurance against long continued or repeated stresses, is a query suggested by an inspection of these curves.

Diagram 6 is introduced merely to show the range in compressibility which is experienced, and the sets developed, in different mixtures. The several curves refer to hooped columns, excepting the 1:1 mortar. They are plotted because of their greater strength over the plain mixtures, but the curves are similar in their characteristics.

The moduli of elasticity at successive stages, referring to values over a range of 500 lbs. per sq. in. next above the initial load, are shown on diagram 7. In obtaining these values the columns were loaded with successive higher stresses and then returned to the range from 100

*Paper read at the June, 1906, meeting of the American Society for Testing Materials.
†Watertown Arsenal, Massachusetts.

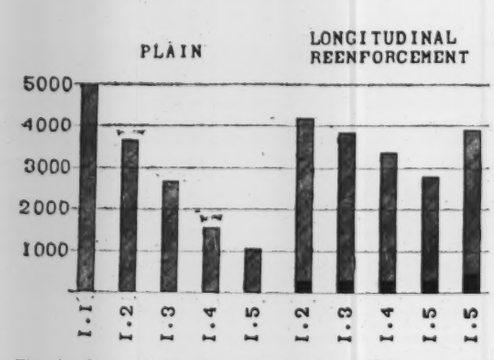


Fig. 1. Compressive Strengths in Lbs. per Sq. In. of Plain and Reinforced Mortar Columns of from 1-1 to 1-5 Cement and Sand Mixtures.
(The black areas in the reinforced columns show the relative amounts of reinforcement.)

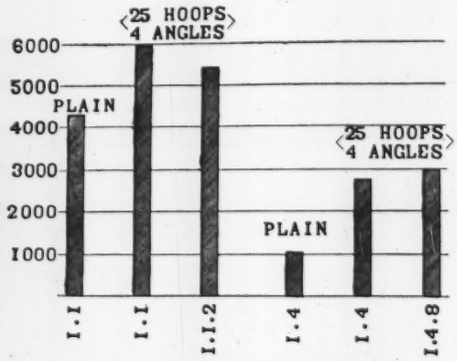


Fig. 2. Compressive Strengths of Rich and Lean Mortar and Concrete Columns Reinforced with Bars and Hoops.

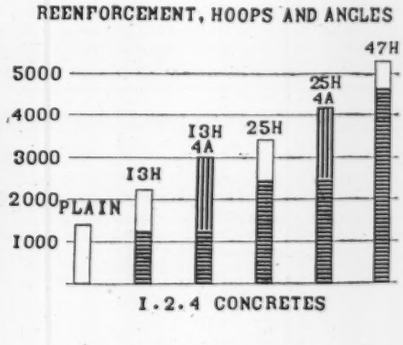


Fig. 3. Compressive Strengths of 1-2-4 Concrete Columns with Various Forms of Reinforcement as Indicated.

to ... lbs, at which time the micrometer observations were made. The numerical values were as follows:

1:1 MORTAR, PLAIN.

Original value of E	3,378,000	lbs. per sq. in.
After a load of 1,000 lbs.	3,247,000	"
" 1,500 "	3,247,000	"
" 2,000 "	3,205,000	"
" 2,500 "	3,165,000	"
" 3,000 "	3,086,000	"
" 3,500 "	3,086,000	"

1:2:4 CONCRETE, 25 HOOPS.

Original value of E	2,874,000	lbs. per sq. in.
After a load of 1,000 lbs.	2,551,000	"
" 1,500 "	2,016,000	"
" 2,000 "	1,582,000	"
" 2,500 "	1,337,000	"
" 2,800 "	1,244,000	"

1:2:4 CONCRETE, 48 LIGHT HOOPS, 4 ANGLE BARS.

Original value of E	1,220,000	lbs. per sq. in.
After a load of 1,000 lbs.	899,000	"
" 1,500 "	801,000	"
" 2,000 "	912,000	"

1:3:6 CONCRETE, CINDER, 25 HOOPS.

Original value of E	702,000	lbs. per sq. in.
After a load of 850 lbs.	538,000	"
" 1,000 "	426,000	"

beams, when they are studied in the manner in which the present column tests are being carried out.

It may be remarked in passing that compressive stresses exceeding 50,000 lbs. per sq. in. are of frequent occurrence in columns tested to their ultimate resistance, whence it follows that steel employed for longitudinal reinforcement should have an elastic limit not less than the above.

In addition to the changes in the modulus above referred to, the curves of ascending and descending stresses do not coincide, the departure increasing with the application of successively higher loads. This behavior is indicated upon diagram 8, which shows the stress-strain curves of four columns.

These curves were obtained after the columns had been loaded as follows:

1:1 mortar, plain, after having been loaded with	3,500 lbs. per sq. in.
1:1 mortar, 25 hoops and 4 angle bars, after having been loaded with	5,700 "
1:4:8 concrete, 25 hoops and 4 angle bars, after having been loaded with	2,500 "
1:2:4 concrete, 25 hoops, after having been loaded with	3,200 "

of steel bolts which tighten end plates, between which the columns are located.

In conclusion, it is believed that the present tests are sufficiently advanced to indicate clearly that high ultimate strength may be reached by each of the three current methods of practice; that is, by the use of rich mortars or concretes, by means of sufficient longitudinal metal reinforcement, and by means of adequate hooping or other external lateral support. Rigidity of the columns will be attained by the use of rich cement mixtures or by means of longitudinal steel bars. The rigidity of the mortar or concrete itself is effected practically only by the use of rich cement mixtures. Economy of cost, to attain compressive strength, within certain limits, will be promoted generally by the plentiful use of cement.

CONCRETE VIADUCTS OR TRESTLES with flat floors instead of arch spans were described in our issue of May 31, but the viaducts then mentioned were all continuous monolithic structures. In a similar structure recently built, however, the spans are separate from each other

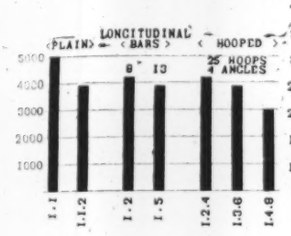


Fig. 4. Diagram Showing Columns that Proved Especially Strong Because of Composition or Reinforcement.

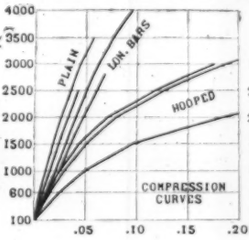


Fig. 5. Diagram Showing Relative Rigidity of Columns Shown in Fig. 4.

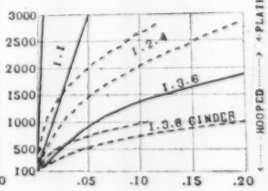


Fig. 6. Diagram Showing Range in Compressibility and the Sets Developed in Different Mixtures.

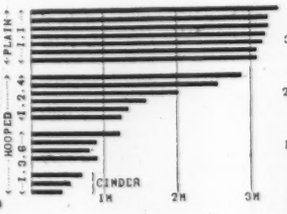


Fig. 7. Diagram Showing Moduli of Elasticity at Successive Stages over a Range of Stress of 500 Lbs. from 100 Lbs. to 600 Lbs. per Sq. In.

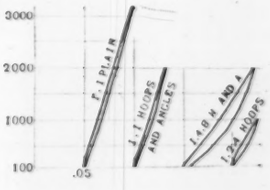


Fig. 8. Diagram Showing Noncoincidence of Curves of Ascending and Descending Stresses.

Neat cement and rich mortars do not show any considerable loss in the value of the modulus of elasticity when examined over an early range of loads succeeding the application of successively higher stresses.

Other mixtures are subject to decided changes. After the application of each higher load there results a difference in the rate of compressibility under lower stresses, the modulus in some instances dropping to less than one-half its original value. It will be understood from this that the proportion of load carried by steel in combination with concrete is subject to great fluctuations. This feature will deserve consideration in the case of reinforced

Concerning the amount of lateral expansion which accompanies the direct compression of the material, observations have been made on several columns. Measurements have also been made upon the expansion of the hoops of hooped columns during testing. Adjacent hoops have been found working under very different strains. The location of final rupture in unreinforced columns is often indicated prior to reaching the maximum load, by reason of the greater lateral expansion in that vicinity.

Columns have been made for test by long continued loads, and are now sustaining stresses of different amounts. The loads are maintained by means of groups

and from the piers, each span being a reinforced-concrete slab 16 ft. long (c. to c. of piers) and 28 ft. wide, with a thickness of 24 ins. at the middle and 22 ins. at the sides. At each side there is a curb 11 ins. high and 8 ins. wide to retain the ballast. There are five of these spans, giving a total length of 80 ft., exclusive of abutments. The structure is of gravel concrete and contains 520 cu. yds. of concrete and 17 tons of steel bars. It is on a cut-off for straightening the line of the Chicago, Burlington & Quincy Ry., near Hannibal, Mo., and was designed by Mr. C. H. Cartlidge, M. Am. Soc. C. E., Bridge Engineer of that road.

TABLE I.—SHOWING CONCRETE AND MORTAR COLUMN TESTS AT WATERTOWN ARSENAL, MADE SUBSEQUENT TO LAST PUBLISHED RESULTS, IN TESTS OF METALS, 1905. COLUMNS 8 FT. HIGH.

No. of tests.	Diameter of column.	Composition. Cement.	Sand.	Stone or cinder.	Kind of stone or cinder.	Age.		Reinforcing metal.	Cross sectional area.	Weight of concrete or mortar per cu. ft.	Compressive strength. Total,	Per sq. in.
	Ins.	Parts.	Parts.	Parts.		Mos.	Days.		Sq. ins.	Lbs.	Lbs.	Lbs.
1718	12.35	1	2	4	¾ to 1½ in. trap rock.	5	8	2-in. mesh wire cage.	119.79	149.6	263,538	2,200
1722	12.25	1	2	4	"	5	13	3-in. mesh wire cage.	117.86	151.3	242,000	2,053
1724	12.45	1	2	4	"	5	13	" " "	121.74	149.4	318,000	2,610
1720	12.25	1	3	6	"	5	8	2-in. mesh wire cage.	117.86	150.1	159,111	1,350
1719	12.45	1	3	6	"	5	8	" " "	121.74	145.7	168,000	1,380
1721	12.40	1	3	6	"	5	8	" " "	120.76	143.1	183,500	1,520
1723	12.34	1	3	6	"	5	12	3-in. mesh wire cage.	119.60	147.6	197,340	1,650
1725	12.35	1	3	6	"	5	11	" " "	119.79	149.6	206,000	1,720
1734	10.40	1	1	0	none.	6	11	none.	84.95	132.6	367,000	4,320
1735	10.40	1	1	0	"	6	12	25 1.5-in. hoops and 4 angles.	84.95	132.6	508,000	5,980
1730	10.45	1	1	2	¾ to 1½ in. trap rock.	5	0	" " " "	85.77	149.1	466,000	5,433
1730	10.38	1	4	0	none.	6	8	none.	84.62	118.7	88,851	1,050
1737	10.40	1	4	0	"	6	8	25 1.5-in. hoops and 4 angles.	84.95	119.9	235,000	2,766
1733	10.40	1	4	8	¾ to 1½ in. trap rock.	6	11	" " " "	84.95	146.6	255,000	3,002
1731	10.40	1	2	4	"	5	16	none.	84.95	150.0	120,000	1,413
1740	10.38	1	2	4	"	6	6	13 1.5-in. hoops.	84.62	149.2	188,900	2,232
1741	10.38	1	2	4	"	6	5	25 1.5-in. hoops.	84.62	148.6	290,100	3,428
1739	10.35	1	2	4	"	6	6	47 1.5-in. hoops.	84.13	149.4	445,000	5,289
1734	10.38	1	2	4	"	6	7	13 1.5-in. hoops and 4 angles.	84.62	150.7	256,300	3,029
1682	10.40	1	2	4	"	0	15	25 1.5-in. hoops and 4 angles.	84.95	144.2	280,400	3,005
1726	10.30	1	2	4	"	5	12	" " " "	83.32	150.7	349,000	4,189
1728	12.00*	1	2	4	"	5	12	" " " "	113.10	149.4	370,000	3,271
1746	10.36	1	2	4	¼ to ¾ in. trap rock.	5	12	48 1-in. hoops and 4 angles.	84.30	147.2	324,000	3,843
1744	11.95*	1	2	4	"	6	0	" " " "	112.16	148.2	335,200	2,989
1732	10.34	1	3	6	¾ to 1½ in. trap rock.	5	11	none.	84.62	148.2	63,465	750
1742**	10.38	1	3	6	"	6	4	25 1.5-in. hoops.	84.62	145.9	162,300	1,918
1748	10.38	1	3	6	cinders.	6	4	" "	84.62	101.3	96,000	1,134
1727	10.35	1	3	6	¾ to 1½ in. trap rock.	5	11	25 1.5 in. hoops and 4 angles.	84.13	148.3	325,000	3,863
1729	12.02*	1	3	6	"	5	3	" " " "	113.47	144.6	299,000	2,634
1747	10.36	1	3	6	¼ to ¾ in. trap rock.	5	11	48 1-in. hoops and 4 angles.	84.30	138.9	212,000	2,515
1745	11.95*	1	3	6	"	5	13	" " " "	112.16	142.2	259,000	2,309
1714	12.00	1	2	4	¾-in. trap rock.	5	11	3 Kahn bars and 11 hoops.	113.10	145.4	265,500	2,350
1717	12.00	1	2	4	"	5	8	" " "	113.10	145.6	237,510	2,100
1712	12.45 x 12.47	1	2	4	"	5	11	4 Kahn bars and 11 hoops.	155.25	143.4	279,450	1,800
1713	12.45 x 12.47	1	2	4	"	5	11	" " "	155.25	144.6	394,000	2,538
1716	12.48 x 12.49	1	2	4	"	5	10	" " "	155.88	143.8	296,172	1,900
1715	12.45 x 12.49	1	2	4	"	5	10	4 Truscon bars and 11 hoops.	155.50	145.8	367,500	2,363
1705	12.02	1	3	6	¾ to 1½ in. trap rock.	5	5	none.	113.47	146.1	164,100	1,446
1706	12.02	1	3	6	¾ to 1½ in. pebbles.	5	3	"	113.47	128.0	143,000	1,260
1707	12.00	1	3	6	cinders.	5	0	"	113.10	101.4	78,900	698

* Exterior Shell.

** Column No. 1742 was defective; one hoop was displaced during construction.

ANNUAL CONVENTION OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS AT THOUSAND ISLANDS.

A successful and much enjoyed convention was held last week at Thousand Islands, near the head of the St. Lawrence River, by the American Society of Civil Engineers. About 350 persons were registered in headquarters at the Hotel Frontenac, Round Island, N. Y.; nearly 200 of these were members of the society, the others being wives, daughters and sisters. The convention was favored by good weather; the black bass were in fairly good appetite, and the golf grounds were in the neatest possible shape. Consequently, the four days of the convention (Tuesday, June 26 to Friday, June 29) were well utilized.

Five professional and business sessions were held. The subject of qualifications for membership in the society raised perhaps the most lively discussion; it came before the meeting through certain proposed amendments to the Constitution, upon which a special committee has been working since the annual meeting of last January. Other subjects considered were: "Engineering Education," "Sewage Disposal," "Prevention of Conflagrations," "Patent Protection," and "Rail Sections and Specifications."

Of the social doings of the convention, the one which brought perhaps the most general pleasure was a river excursion to the estate of Mr. Charles MacDonald, at Gananoque, Ont., on the Canadian bank of the St. Lawrence. A reception by Mr. and Mrs. MacDonald, followed by lunch, formed the central feature of a steamboat trip of some forty miles through the delightful channels of the Thousand Islands. Dancing in the hotel parlors and a prize golf tournament were other social features of the convention.

The business and professional proceedings are briefly reviewed in the following.

STEEL RAILS.

The subject of steel rails, the consideration of which had been adjourned from the annual meeting of January, 1906, came before the society again at this convention. At the January meeting a committee, appointed four years ago, made a report on Rail Section, Chemical Composition, and Specifications. Eight members of the committee signed the majority report, which left the present "Am. Soc. C. E. Standard" sections unchanged, and gave specifications for manufacture and test of (1) acid bessemer and (2) basic open-hearth steel rails; four members made dissenting minority reports. These reports were referred to the present convention for further consideration and action. They were taken up at the first session of the convention. The sentiment was expressed that the committee should come to full agreement before asking for its discharge, but two members of the committee emphatically stated that it does not seem possible to secure agreement. However, the subject was recommitted until the next annual meeting (January, 1906), with instructions to the committee to again canvass the matter and, if possible, submit a report on which all can agree.

It is noteworthy that the same subject, Steel Rails, brought about a disagreement in the American Society for Testing Materials at Atlantic City, N. J., less than a week before. In that case the only matter at issue was Specifications for manufacture and test; rail sections were not discussed, the standard sections of the American Society of Civil Engineers (designed and adopted in 1893) being accepted as standards. The causes of the disagreement were noted in our last issue (June 28, 1906, p. 726). Wholly different grounds are responsible for the failure of the American Society of Civil Engineers' committee to disagree. Two of the dissenting minority members hold that the standard rail-sections should be modified. The other two suggest their belief that modifications of the standard forms of section are advisable, but consider that no change can be made before much fuller investigation of the service-value of the present sections is obtained; their dissent from the majority report is based mainly on various requirements of the specifications for manufacturing methods and processes, and not (strange to say) on the specifications for testing the finished rails. Apart from the question of form of rail section, the disagreement in the committees of the two societies is, therefore, due essentially to rather antithetic views: The opposition in the American Society for Testing Materials holds out for more rigid tests, believing that rigid control of the manufacturing processes is not sufficient, while the opposition in the American Society of Civil Engineers demands more rigid limitation of the rolling mill methods and chemical requirements, apparently on the theory that it is not sufficient to prescribe rigid tests. An exceptional phase of the situation in the latter society's committee is that one of the dissenting members, Mr. P. Roberts, Jr., (Pencoyd Iron Works, Pencoyd, Pa.) recommends adding a test for tensile strength and elongation (the test-piece to be taken from the rail-head), and also would fix a limiting allowable deflection in the drop test of finished rails, both of which are rather novel proposals.

A HIGHER STANDARD FOR MEMBERSHIP.

A sentiment for revised standards of membership, generally higher than those at present in force, found expression at the last annual meeting of the society in the appointment of a committee to consider certain proposed amendments to the Constitution on the matter of qualifications for membership, and to recommend what changes in the present classification of membership and qualifications for each class are desirable. In response to these instructions, the committee submitted a set of amendments which were read and discussed at the present convention. Aside from minor changes, the principal novelties proposed in these amendments are: (1) raising the age limit for full membership from 30 to 33; (2) requiring that candidates for Member must have attained "a recognized position of honorable high standing in the profession;" and (3) dropping the grade of Fellow.

An extra session was convened on the evening of June 27 expressly for the discussion of these amendments. The upshot of the matter was that the amendments were referred back to the committee for revision in accordance with numerous criticisms and suggestions made at the convention; their revised form is to be submitted to the membership at large some time previous to the next annual meeting, when they will come up for final action.

The discussion which preceded the vote to recommit dealt with a large number of details of the propcsed amendments. Two or three of these details may be of general interest.

The amendments provide among other things: "Corporate Members shall be Civil Engineers, the profession of Civil Engineering being here defined as including the branches commonly called Civil, Mechanical, Mining, Electrical, Military and Naval Engineering, and embracing Architecture and Naval Architecture." This complicated definition raised much criticism. To begin with, Mr. J. C. Trautwine, Jr., (Philadelphia, Pa.) who submitted a minority report on the amendments, objected both to the indirectness of defining Civil Engineering when the term at issue is "Civil Engineer," and to the inconsistency of including Military Engineers among Civil Engineers. But he found little support for his views at the convention. Mr. C. C. Schneider (Philadelphia, Pa.) then suggested a definition of Civil Engineer which omitted the detailed list of branches of engineering and also left out Architect; on a query he stated that Architect was left out intentionally, on the ground that architects are not necessarily engineers in any branch and generally "an architect to-day is nothing but a decorator." This bold declaration at once brought opposition and support to the surface. At the first session, in moving to recommit the report, Mr. R. P. Miller (New York, N. Y.) had already voiced the view that the inclusion of Architecture as a branch of Civil Engineering was not warranted by the facts of to-day, since Architecture is by its own votaries treated as one of the Fine Arts. Messrs. W. C. Furber (Philadelphia, Pa.), J. C. Trautwine, Jr., E. Swens (Pittsburg, Pa.), G. S. Williams, (Ann Arbor, Mich.) and some others opposed the exclusion of architects from the class of Civil Engineers. On the other hand Messrs. S. B. Russell (St. Louis, Mo.), H. B. Seaman (New York, N. Y.), Kuichling (New York, N. Y.) and others supported the view that, while an architect if he practices civil engineering in his work is a civil engineer and is therefore eligible to membership, he should not be made eligible by the mere fact that he is an architect (or a professor of architecture). Mr. Russell moved that it be the sense of the meeting that architects, unless otherwise qualified for membership, be eligible to the class of Associate only; but this motion was laid on the table, after discussion.

Further on the matter of definition of Civil Engineer, Prof. G. S. Williams suggested that instead of a classification of engineering there should be given a definition like the famous one of Tredgold's, except that "art and science" be put in place of "art," to make it read "Engineering is the art and science of utilizing the great sources of power in nature, etc."

The clause in the qualifications for Member which reads "he shall also have attained a recognized position of honorable high standing in the profession," contributed a large share of the evening's discussion. Mr. J. A. Powers, (Troy, N. Y.) led in opposition to this peculiar and indefinite requirement; he claimed that standing often was a function of "pull" and self-advertisement rather than of merit, and urged that the society take no action tending to "prefer the high stepper to the wheel-horse," forgetful of the old-fashioned virtue of modesty. Mr. A. Allen (Chicago, Ill.) argued that the proposed clause substituted an opinion for a fact; only professional attainments or achievements should be a criterion for qualification to membership. Prof. E. Marburg (Philadelphia, Pa.) favored specific requirements as against one based on personal and hence variable opinion. Mr. T. L. Condron (Chicago, Ill.) held that the proposed clause would give dangerous power to those entrusted with applying it, power which might be badly abused by a narrow clique; in the extreme case it might require residence in a specific ward of New York City to give an applicant such "recognized position" as the Board of Direction would deem sufficient for membership.

On the other side, Mr. J. C. Trautwine, Jr., explained that "recognized position" was intended to mean only a decent standing of professional ability and honor. Mr. C. W. Hunt, secretary, related that the Board frequently found that a candidate offering all the required qualifications of experience, grade of employ, etc., would be so variously reported on by members in response to the usual circular inquiry as to make it hard for the Board to conclude that he was fairly entitled to membership; for this class of cases the additional power conferred by a clause as proposed is very convenient. Mr. J. Owen (Montclair, N. J.) thought that the society should have some moral qualifications for membership, and that this clause would enable them to be demanded. Mr. C. F. Loweth (Chicago, Ill.) favored the clause with the omission of the word "recognized." The discussion was continued for a long time; besides those noted, Messrs. J. A. Ockerson (St. Louis, Mo.), M. J. Riggs (Toledo, O.) and some others took the liberalist side, while Messrs. M. R. Sherrerd (Newark, N. J.), H. Goldmark (Montreal, P. Q.), G. S. Williams (Ann Arbor, Mich.) and others took the moralist side. A motion by Mr. Powers expressing the "sense of this meeting" against the clause objected to was tabled on motion of Prof. G. S. Williams.

After this discussion of the proposed qualifications for member, discussion of the other sections of the amendments was cut off, and thereupon the motion to recommit, as already noted, was carried.

ENGINEERING EDUCATION.

A topical discussion on Engineering Education, a subject which rarely fails to bring out ample amount of discussion, occupied most of the third session of the convention. Prof. G. F. Swain (Boston, Mass.) opened the subject with two short papers, entitled, respectively, "What is the Best Preparatory Education for the Civil Engineering Profession," and "Is Technical Training the Best Education for Executive Work." On the first subject the author offers a number of specific conclusions, as follows:

(1) A technical education as given in our civil engineering schools is, if properly appreciated and made use of, the best preparation for the practice of the profession, and at the present time it is almost a necessity.

(2) In laying out an engineering course, the aim should be first of all to develop broad-minded men, who can observe correctly, reason logically, express themselves in language or on paper, men with imagination and with character, and with good physical development. [The same might be said of training for any other occupation or profession.—Ed.]

(3) Useful subjects of study, which admit and require training in thinking, should be preferred to studies which are mere accomplishments.

(4) Studies which involve discipline of the mind and observation should be preferred to studies which merely give information.

(5) Subject to the above restrictions, *what* is taught is not so important as *how* it is taught. The teaching profession should be better paid and made more attractive to able men.

(6) The curriculum leading to any of the engineering professions should be almost entirely prescribed.

(7) The choice of a profession should be made as early as practicable, and a continuous course arranged with that profession in view, from the beginning of the higher education. A course of five years or perhaps of six years, either in one institution or in two, seems desirable for a thorough preparation.

(8) The American Society of Civil Engineers should recognize the dignity of the teaching profession by making experience in teaching equivalent to experience in practice as a requirement for membership.

The second paper of Prof. Swain answers its question by a general affirmative, which, however, is hedged round with qualifications, thus:

While ready to admit the fact that many men technically trained do lack the breadth of view and adaptability which are essential in executive work, the writer believes nevertheless that technical training, if the course of study is properly laid out, with a proper proportion of liberalizing studies, and pursued under teachers who direct the students always toward the larger view, is the best preparation for executive work.

The discussion which followed dealt mainly with the first paper. The subject is one that never fails to draw discussion, and its pleasant feature is that the number of opinions expressed is always at least equal to the number of speakers; agreement between two speakers seems impossible. As the direct value of such discussions to the practical man is rather doubtful, however, we omit more detailed note of what was said at the meeting. One novel proposal deserves mention, perhaps. Prof. E. Marburg (Philadelphia, Pa.) made a strong argument for the view that improvement in technical schools must be sought in improving the men rather than the machine. The buildings and equipment of the schools have developed greatly, in response to the demands put by the greatly increased number of students, and the curricula are also in reasonably satisfactory condition to-day; but the teaching force has not advanced in proportion. While the number of low-grade teachers was increased, no corresponding increase was made in the number of experienced professors, and as a result the student to-day receives less of the personal influence which professors of ability and force exert, than formerly. Prof. Marburg thereupon moved

That a committee be appointed to report on the status of engineering education in this country, and to recommend measures calculated to place it on the highest plane of efficiency.

This motion was carried at a later session, and was referred to the Board of Direction. Its aim is to draw attention to the urgent need for more men of high ability, professional standing and experience on the faculties of technical colleges.

The oft-debated matter of patents recurred in a paper by Mr. D. A. Usina (New York, N. Y.) under the title "The Protection of the Intellectual Property of Civil Engineers." The author supported the view that civil engineers act properly when they take patents on improved processes or constructions, and that it would be fair that the life of civil engineering patents should be greater than the regular 17-year term, because such improvements generally deal with large or unusual works, and any single one finds very infrequent application. He also made a plea for concerted action against piracy of engineering inventions. Mr. J. P. A. Maignen (Philadelphia, Pa.) spoke in support of these views, and further argued that the practice of public authorities and some private corporations to discriminate against the use of patented articles is wrong and foolish.

SEWAGE DISPOSAL.

In a paper entitled "The Advance in Sewage Disposal," Mr. G. C. Whipple (New York, N. Y.) gave a classified review of the present-day processes and problems in sewage treatment. The "advance" mentioned in the title of the paper has been not so much the development of new processes, says the author, as the thorough trying-out and perfecting of old ones. England leads in sewage disposal, and naturally so because the density of population and the scarcity of large rivers makes the subject a vital problem in that country. A recent visit to England enabled the author to discuss his subject in the light of most up-to-date English practice, and gave him opportunity to observe the working efficiency of the various treatment processes and their modifications. The author divided sewage treatment into three parts, namely (1) Preparatory Processes, (2) Purification Processes, and (3) Finishing Processes; each of which he classified and discussed in some detail.

Mr. E. Kuichling (New York, N. Y.) opened discussion with a reference to the difficulties introduced by trade wastes. Besides the difficulty of purifying these wastes, a further difficulty resides in the fact that as a town grows the nature of its industries, and hence the character of its trade wastes, usually changes; while originally the character of the sewage may have called for one kind of plant, in the course of a few years a different method of treatment may be rendered necessary by the change in trade wastes. Mr. Kuichling flatly stated that, in general, a sewage disposal plant is unavoidably a nuisance, not only by its smells but also by the multitudes of flies and other insects which it attracts to the neighborhood. For this reason a plant should always be located far from habitation. Concerning processes he asserted that the new ones have often proved somewhat disappointing, whereas old processes have in recent years shown more merit than was previously conceded to them. Screening and sedimentation are prominent among these, and further advance in their application is expected.

Mr. J. W. Alvord (Chicago, Ill.) spoke on the theme that most of the ideas represented in sewage treatment are old, having been discovered one or two generations ago, and in some cases rediscovered one or more times since. The septic purification process is notable in this respect. This same process illustrates also how an erroneous deduction may mislead the entire technical and scientific world for years. Just at the time when bacteriology was being developed and a proper understanding of the action of the septic tank arrived at, the antiseptic theory of sewage treatment was broached. It was reasoned that by putting antiseptic substances into sewage its decomposition would be prevented. But the final disposal of all sewage is this very decomposition, and the antiseptic treatment merely retarded its beginning by killing off the bacteria already there. The proper appreciation of septic sewage treatment was delayed through this error by at least twenty years.

Mr. W. S. Johnson (Boston, Mass.) broke a lance for the intermittent filtration process. Quoting from a recent editorial which said that "the rise of intermittent filtration has nearly reached its culmination," and that many of the New England plants using this process are abandoning it or else ceasing operation, he asserted that the facts concerning the New England plants do not bear out the conclusion, and claimed that the process has proved a great success and is destined to much wider use. Some of the New England plants in question have been outgrown and are overloaded; while most of the plants have trouble at certain seasons due to accumulation of solid matter after long periods of continuous working, none of them are inoperative. Intermittent filtration in his opinion represents the highest development of sewage purification.

Mr. J. H. Gregory (Columbus, O.) showed two forms of nozzle used in the sprinkling-filter beds of the Columbus Sewage Experiment Station, and the nozzle used in the Salford (England) plant. The later Columbus nozzle is a complete success, being absolutely non-clogging. It has a vertically-directed orifice of $^{9}/_{16}$-in. diameter, with rounded approach, and above this is suspended a cone, pointing downward, of 90° apex angle, held by two arms extending up from the nozzle casting. The arms are thin in tangential direction, and are ground to knife edges on the inner and outer edges; the effect is that the sheet thrown out by the cone heals again after passing the arms, and on breaking up produces a complete circle of spray. This nozzle operates under lower head than any other, and covers 77% of the surface.

Mr. J. Owen (Montclair, N. J.) told of a 50 × 18-ft. septic tank, taking 70,000 gals. sewage per day, which was closed up tight and was run 6 yrs. without inspection. At the end of that time it had only a very small amount of sludge at the bottom, and about 15 ins. of scum; repeated inspection at later periods showed that these amounts are practically constant (without cleaning).

THE PREVENTION OF CONFLAGRATIONS.

A very extended paper, replete with interest, was presented by Mr. J. R. Freeman (Providence, R. I.) under the title "What are the Best Means for the Prevention of Conflagrations in Large Cities." It was an extemporaneous address rather than a paper; while on this account it lacked somewhat in systematic arrangement and classification, it lost nothing in interest. The subject is large, and its proper treatment, in view of the scarcity of previous discussions, requires marshaling of fact and argument at great length. The half-hour available for the presentation of the address obviously could suffice only for a partial treatment of the subject; even of this we can give only a few brief notes.

The author's experience convinces him that cities *can* be built conflagration-proof, or, rather, that buildings of the most dangerous occupancy common in cities can be made proof against destructive fire; from the latter proposition the former follows as a mere synthetic summation. The truth of these statements lies primarily in the work and experience of the factory inspection and insurance organizations of New England. A cotton-mill, for example, filled with quick-moving machinery and containing great quantities of highly combustible material, can be made proof against a general fire whether originating within the structure or attacking it from without. A brilliant example of this was furnished by the factory building of the Western Electric Co.'s San Francisco branch, which, standing in the center of the area of greatest fire in the recent San Francisco disaster, remains to-day practically unharmed. In the design of this building Mr. Freeman was consulted on various points, because of his long connection with the factory mutual insurance interests, but the main credit for the design belongs to Mr. W. R. Patterson, of the Western Electric Co.

The building is in a location surrounded by the most combustible kind of store and dwelling structures. It has brick walls and timber floors of "slow-burning mill construction." The floors are of 2 × 6-in. timbers set on edge solidly side by side, making a 6-in. floor, supported by 16-in. beams. The roof, of flat pitch, is 4 ins. thick, of similar type, and is covered with tar-and-gravel. The window area is relatively large; the glazing is wire-glass in metal sash and frames. Fire-shutters, though considered better than wire-glass, were not put in, on account of the large windows, and because wire-glass in metal frames, together with the sprinklers, was considered adequate. The interior has a complete automatic-sprinkler equipment, supplied from a

50,000-gal. tank 20 ft. above the roof. A 20,000-gal. cistern in the basement and an electric fire-pump of 4,000 gals. capacity were also provided. As the electric power and the city water-supply were instantly cut off by the earthquake, the fire pump was of no use. Before the fire reached the building, the city fire department, lacking water, drew from the roof-tank in order to fight the fire among the frame buildings near by, so that the sprinkler supply was gone by the time the fire reached the factory.

When the fire first reached the building, a force of employees was at hand to fight the attack. The heat became so intense that the radiation through the wire-glass ignited window-curtains and woodwork, and later many other cases of incipient fire occurred; these were all taken care of by the employees, who tore away the loose combustibles and operated a bucket brigade from the cellar cistern. During this attack even the putty on the inside of the sash took fire, and about a score of automatic-sprinkler heads opened, so great was the heat in the building. Later in the day came a second attack, when the fire came up from the opposite side, where combustible buildings 30 ft. away closed off a court filled with cross-arm lumber. At this time most of the employees had left, thinking the danger insurmountable, but two or three stayed in spite of warnings, and by hard work of the same kind as that of the morning they kept up a successful fight till the fire around the building had burned itself out.

The author then enlarged on the value and efficiency of fire-shutters, citing a conflagration at Lynn, Mass., where a shoe-factory was saved by its fire-shutters against a fierce attack of fire lasting several hours. Then he directed attention to the value of private fire-pumps, which alone held one front of the conflagration at Paterson, N. J., several years ago. He then referred to the Baltimore fire, which he characterized as the richest field for conflagration studies ever offered to engineers. This fire showed clearly that the weakest point of the "fireproof" building is the window. Yet he believes that this point can be made conflagration-proof in all cases by fire-shutters; even in office buildings protection can be provided by inside metal shutters.

In the design of such protection, as in all other phases of fireproofing, it is important to know the approximate maximum temperatures reached in conflagrations. The Baltimore fire gave opportunity to determine this point quite well. The behavior of various substances, chiefly of the metals, furnished the data; typewriters were specially good records of temperature. Glass, thin sheet brass, heavy brass, were successively melted; and in one or two cases the incipient fusion of cast-iron was observed. Actual samples of the fused substances tested in the laboratory gave melting-points at 1,650° for glass, 1,700-1,800° for brass, and 2,200° F. for the cast-iron. No specimen of steel or wrought-iron, even in thin sheets, showed evidence of incipient fusion; in fact, in his whole experience such beginnings of fusion in sheet-iron were noted only once, where chemicals made a fire especially hot. These facts, with others of parallel tendency, lead Mr. Freeman to conclude that a resistance to temperatures of 1,700-1,800° for one hour is the highest that need be required of materials intended to be conflagration-proof.

After some further remarks on fire-shutters, and an appreciative tribute to the fire-protection work of the late Mr. James B. Francis (former president of the society) at Lowell, Mass., Mr. Freeman closed with an appeal for high service pressures in water-supply systems. He doubts whether the leakage trouble would be serious, inasmuch as leaks would be sooner discovered and repaired. The experience of Syracuse, N. Y.; Fall River, Mass. (120 lbs.); New Britain, Conn. (90 lbs.); Fitchburg, Mass. (120-140 lbs.), and other cities, was cited to show that a high-pressure system can be operated with success, and that the water consumption need not be large. The inestimable advantage of high line pressure is that the whole front of a conflagration may be opposed by an efficient fire-fighting line, whereas otherwise the line can be only as long as the available steamers will form. And a city can never have or borrow sufficient number of steam fire engines to cover the front of a large conflagration.

The evening was so far gone when Mr. Freeman ended the presentation of his paper that no time was taken for discussion. Mr. R. P. Miller (New York, N. Y.), Prof. G. S. Williams (Ann Arbor, Mich.), Mr. C. E. Goad (Toronto, Ont.) and others announced their intention to contribute discussions. Prof. Williams stated that he would submit an argument against the high-pressure water-supply plea of the author. Mr. Miller took occasion to press the point that practical progress in building fireproof must be secured by educating the public to appreciate the need for providing against the conflagration danger; actual administration of the best existing building laws has demonstrated that laws and insurance requirements are at most partially successful in producing fireproof cities.

THE DERAILMENT OF AN EXPRESS TRAIN on the London & Southwestern Ry., near Salisbury, England, on July 1, resulted in a wreck that killed 27 persons and injured a dozen more. The train was one known as the American Line Express, taking London passengers from the American Line steamers at Plymouth, and is noted for its fast time, averaging 60 miles per hour for the 230 miles from Plymouth to London. As made up on the day of the wreck it consisted of an engine, three first-class corridor coaches and one combination guards' van and buffet. It had taken on 43 passengers from the steamship "New York." At Salisbury the line has a curve passing through the station and rising to cross over a street. It was on this curve that the derailment occurred, the train, after leaving the track, plunging first into the rear cars of a milk train, then into the bridge and finally into another locomotive.

PERSONALS.

Mr. Herman F. Ball has been made Vice-President of the American Locomotive Automobile Co.

Mr. John H. Hudson, Jr., has accepted a position with W. R. Grace & Co., Valparaiso, Chile.

Mr. Andrew W. Munster, Chief Engineer of the Chicago Great Western Ry., will sever his connection with the road July 15.

Mr. A. J. Vance has been appointed representative of Buffalo Forge Co., for Cincinnati, Ohio, and has offices at 403 Neave Building.

Mr. William Joerg has been appointed Superintendent of Water-Works of North Tonawanda, N. Y., to succeed Lewis E. Gray, deceased.

Mr. Frank Miles Day has been appointed, by Secretary of State Elihu Root, Delegate on the Part of the United States to the seventh International Congress of Architects, to be held in London, July 16 to 21.

Mr. Julian Griggs, M. Am. Soc. C. E., and formerly City Engineer of Columbus, Ohio, has resigned as Assistant Engineer of the Norfolk & Western Ry., at Norfolk, Va., to accept the position of Chief Engineer of the Scioto Valley Traction Co., of Columbus, Ohio.

Mr. Calvin Winsor Rice has been appointed to the position of Secretary of the American Society of Mechanical Engineers and assumed office on July 1. Mr. Rice was born at Winchester, Mass., Nov. 4, 1868, and graduated from the Massachusetts Institute of Technology in 1890. While a student Mr. Rice occupied his vacations in the employment of the Thomson-Houston Electric Co., and after graduation he entered the employ of the same company with which, and its successor, the General Electric, he has been connected ever since. Beginning at the bench with the company named, Mr. Rice worked up through the positions of foreman, draftsman and office engineer to the position of District Engineer of the Central States. In 1895-8 Mr. Rice was engaged in installing and operating complete steam, hydraulic and electric plants in Colorado and Montana. In 1898 Mr. Rice returned east, becoming Electrical Engineer of the Kings County Electric Light & Power Co., and afterwards Electrical Engineer of the Consolidated Telegraph & Electric Subway Co., of New York. Since 1904 Mr. Rice has been Consulting Engineer of the New York office of the General Electric Co., making a specialty of the steam turbine. Mr. Rice is a member of the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, the Institution of Electrical Engineers of Great Britain (having been proposed by Lord Kelvin) and of the American Association for the Advancement of Science.

Obituary.

Frank E. Stoneman, President of the North A... Lead Co., was killed in an automobile accident at ... Ohio, June 27.

Louis Cassier, publisher of Cassier's Magazine a... Electrical Age, was killed in a train wreck on th... don & Southwestern Ry., at Salisbury, England, J... Mr. Cassier was a native of Boston, Mass., and 44 ... old.

John E. McDonald, President of the Boston & ... York Telephone & Telegraph Co., was killed in th... wreck at Salisbury, England, July 1. He was also ... dent and treasurer of several other telephone and ... graph companies.

ENGINEERING SOCIETIES.

COMING MEETINGS.

AMERICAN WATER-WORKS ASSOCIATION.
July 10 to 14, inclusive. Annual meeting at Bos... Mass. Secy., J. M. Diven, 14 George St., Charleston, S. C.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
July 19 to 20. Semi-annual meeting at Chicago, Ill. Secy., W. M. Mackay, P. O. Box 1818, New York City.

AMERICAN INSTITUTE OF MINING ENGINEERS.
July 23 to Aug. 4. Joint meeting with the Iron and Steel Institute at London. Secy., R. W. Raymond, New York City.

CONCRETE BLOCK MACHINE MANUFACTURERS' ASSOCIATION.
Aug. 8, 9. Annual meeting at Detroit. Secy., S. L. Wiltse, Jackson, Mich.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Aug. 15 to 17. Annual convention at New Haven, Conn. Secy., Frank P. Foster, Corning, N. Y.

LEAGUE OF AMERICAN MUNICIPALITIES.
Sept. 26 to 28. Annual convention at Chicago, Ill. Secy., Jno. MacVicar, Des Moines, Ia.

THE IRON & STEEL INSTITUTE.—As previously announced a joint meeting of the Iron and Steel Institute and the American Institute of Mining Engineers will be held in London July 24 to 26. The office of the London reception committee will be at 28 Victoria St., Westminster, the offices of the Iron and Steel Institute. They will be open from 10 a. m. to 5 p. m. for registration, the issuing of badges, programs, etc. Monday evening President and Mrs. Hadfield will give a reception, while Tuesday morning a general meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers, Great George St., Westminster. Tuesday afternoon will be given over to inspection visits, followed in the evening by a reception by the Mayor and his wife. Wednesday morning there will be a general meeting of the American Institute of Mining Engineers, while Thursday morning there will be a joint meeting of the two institutes. Inspection trips to factories and places of interest have been arranged for Wednesday and Thursday afternoons and Friday and Saturday, while the evenings will be devoted to pleasure. Hotel headquarters for Americans will be at the Westminster Palace Hotel, Hotel Cecil and St. Ermin's Hotel. For the week following the joint meeting of the institutes a tour to the iron-making districts has been organized for the American visitors.

The following papers will be read before the Iron and Steel Institute:

"Machine Molding," P. Bonvillain; "Tempering and Cutting Tests of High Speed Tool Steels, Dr. H. C. H. Carpenter; "The Nodulizing and Desulphurisation of Fine Iron Ores," A. Ladd Colby; "Belgian Practice in Large Gas Engines," Prof. H. Hubert; "Electric Steel Smelting," E. C. Ibbotson; "Different Methods of Blast Furnace Refrigeration and Their Power Requirements," J. E. Johnson, Jr.; "The Crystallography of Iron," F. Osmond; "German Practice in Large Gas Engines," K. Reinhardt; "The Development of the Roe Puddling Process," James P. Roe; "The Constitution of Iron Carbon Alloys," Albert Sauveur; "The Influence of Silicon and Graphite on the Open Hearth Process," Alex. S. Thomas; "British Practice in Large Gas Engines," Tom Westgarth.

At the meeting of the American Institute of Mining Engineers the following papers will be presented:

"Comparison of American and European Rail Specifications," A. Ladd Colby; "Piping and Segregation in Steel Ingots," H. M. Howe; "The Effect of Low Temperature on the Recovery of Steel from Overstrain," E. J. McCaustland; "Improvements in Rolling Iron and Steel," James E. York; "A Simple Distributor for Blast Furnace Charges," David Baker; "A New Colorimeter for the Determination of Carbon in Steel," Charles H. White; "The Gas-Producer as an Auxiliary in Iron Blast Furnace Practice," R. H. Lee; "Internal Stresses and Strains in Iron and Steel," Henry D. Hibbard; "Heat Treatment of Steels Containing 0.50 and 0.80% of Carbon," C. F. Corson; "Methods of Mining, Hauling and Screening Coal at the Mines of the Aldrich Mining Co. at Brilliant, Alabama," T. H. Aldrich, Jr.; "Continued Discussion of the Gayley Dry-Air Blast Process."